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MEASUREMENT AND ANALYSIS OF NOISE FROM FOUR AIRCRAFT DURING APPROACH AND DEPARTURE OPERATIONS (727, KC-135, 707-320B, AND DC-9)

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16. Abstract

The objective of this work was to measure, evaluate, and identify the noise levels along the flight track generated by 727, KC-135, 707-320B, and DC-9 aircraft. The aircraft were directed to operate in a wide variety of takeoff and approach procedures. The effort involved acquisition of acoustical, meteorological, aircraft tracking, and aircraft operational data. Microphones were located four feet above the ground in an array parallel to the flight track along the extended runway centerline up to 10 nautical miles from the runway threshold. All tests were conducted at the National Aviation Facilities Experimental Center (NAFEC) during a four-week period in April 1971.

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Symbol	Definition	Unit
X	Distance perpendicular to runway centerline	feet
Y	Distance along runway centerline	feet
Z	Height above reference point	feet
PNLTM	Maximum tone corrected perceived noise level	PNdB
PNLT	Tone corrected perceived noise level	PNdB
EPNLC	Effective perceived noise level corrected to standard day temperature and relative humidity	EPNdB
EPNLU	Effective perceived noise level as measured at given test conditions	EPNdB

INTRODUCTION

This report presents the results of a flight investigation of eight takeoff and nine approach noise abatement procedures. Detailed descriptions of the test conditions, as well as the acquisition of acoustic, meteorological, tracking, and aircraft performance data, are discussed. The noise measurement data are discussed in terms of effective perceived noise level. Meteorological data are discussed in terms of ground observations and a limited number of soundings to an altitude of 3000 feet. Aircraft performance data are discussed in terms of altitude and lateral deviation tracking profiles and cockpit instrumentation readouts.

Additional noise measurements were conducted on these same four aircraft in a series of level flights described in Reference 1.

APPARATUS AND METHODS

AIRCRAFT DESCRIPTION

A general description of each aircraft tested is given in Table I. The maximum gross takeoff weight was achieved with the use of ballast. In addition to the normal systems, these aircraft were instrumented with an experimental navigational system which was used primarily for flying the two segment approach.

FLIGHT PROFILE DESCRIPTION

The test evaluation program involved takeoff-climbout and landing-approach operations. A total of eignt takeoff-climbout operations were performed which evaluated the following factors:

(1) Climbout speed

(2) Climbout airframe configuration

(3) Power reductions

(4) Altitude to initiate power reductions

Table I. Aircraft Description

Aircraft	Engine	Maximum Power at Sea Level (lb)	Nominal Gross Weight (lb)
727-100	JT8D-1	14,000	159,000 (Takeoff) 134,000 (Landing)
KC-135A	J57-P-59W	13,750	222,000 (Takeoff) 183,000 (Landing)
707-320B (ADV)	JT3D-3B	18,000	315,000 (Takeoff) 218,000 (Landing)
DC-9-10	JT8D-1	14,000	85,000 (Takeoff) 72,000 (Landing)

The name and description of each profile is given in Table II. Profile 1 is selected as the reference for all takeoff weights of maximum gross landing weight. Profile 5 is the reference for maximum gross takeoff weight. Profile 7 was tested using the 727 and Profile 8 was tested only on the 707-320B aircraft.

Although it was planned to initiate each takeoff-climbout at the same point on the runway, some departures were made using a low approach and rotating at approximately the same point on the runway.

The landing approach flight profiles are listed in Table III. Profile A11A was chosen as the reference for all maximum gross landing weight approaches.

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Table II. Takeoff Procedures

Run No.	Takeoff Weight	Parameters	Segment A-B	Altitude hb	Segment B-C	Altitude hc	Segment C-D	Segment D-E (3000 ft)
T1	Max Land	Speed	V_2 + 10*		250K		250K	
		Thrust	T.O.	400	T.O.	NA	ERCT	NA
		Flap	T.O.		Clean		Clean	
T5	Max T.O.	Speed	V_2 + 10*		250K		250K	
		Thrust	T.O.	400	T.O.	NA	ERCT	NA
		Flap	T.O.		Clean		Clean	
T3	Max Land	Speed	V_2 + 10		V_{zf}**		V_{zf}	250K
		Thrust	T.O.	1000	T.O. EPR-1	NA	EPR-1	Climb T.
		Flap	T.O.		Clean		Clean	Clean
T4	Max Land	Speed	V_2 + 20		V_2 + 20		V_2 + 20	
		Thrust	T.O.	1000	EPR-2	NA	EPR-2	NA
		Flap	T.O.		T.O.		T.O.	
T2	Max Land	Speed	V_2 + 20		V_2 + 20		V_2 + 20	
		Thrust	T.O.	1000	EPR-1	NA	EPR-1	NA
		Flap	T.O.		T.O.		T.O.	
T6	Max T.O.	Speed	V_2 + 20		V_2 + 20		V_2 + 20	
		Thrust	T.O.	1000	EPR-1	NA	EPR-1	NA
		Flap	T.O.		T.O.		T.O.	
T7	Max Land	Speed	V_2 + 20		V_2 + 20		V_2 + 20	
		Thrust	T.O.	1000	EPR-1	NA	EPR-1	NA
		Flap	5		5		5	
T8	Max Land	Speed	V_2 + 10		V_2 + 10		250K	
		Thrust	T.O.	1000	1.6 EPR	2500	1.72 EPR	NA
		Flap	T.O.		14		Clean	

EPR-1 Thrust necessary to maintain straight and level flight at maximum takeoff weight with one engine out
EPR-2 An EPR setting intermediate between EPR-1 and takeoff settings (ERCT)
NA Not applicable
T.O. Takeoff setting
ERCT Enroute climb thrust

* Maximum 15-degree pitch angle
** Zero flap speed.

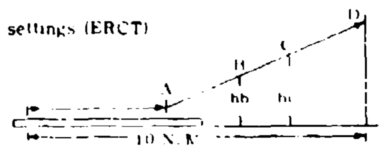
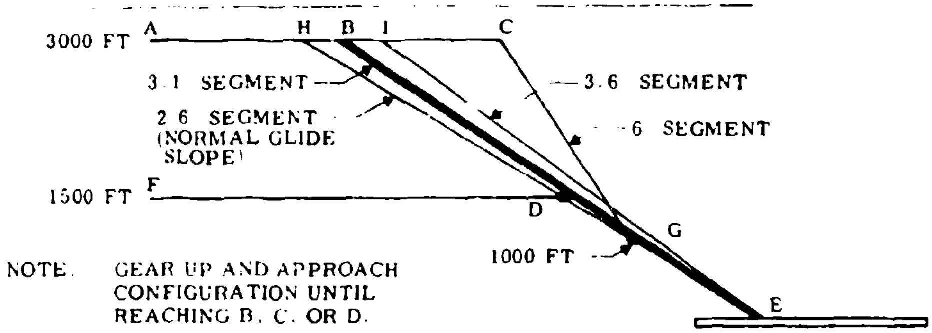


Table III. Approach to Landing Procedures (Maximum Landing Weight)



Profile	Configuration: Land-Max	Land-Alt	Approach
Conventional (1500 ft-F-D-E)	A11*	A12	A13
Conventional (3000 ft-A-H-E)	A21	A22	A23**
Two Segment (A-C-G-E)	A41		
High Glide Slope (3000 ft-A-I-E)	A31		
Middle Glide Slope (3000 ft-A-B-E)	A51		

* Segment F-D of profile A11 will be flown at two different configurations: A11A as identified. A11B will be flown at a lesser flap setting.

** Reconfigure to landing flap, max., at 500 feet.

These operational procedures were used to investigate the noise reduction attributable to the following:

(1) Airframe/thrust configuration changes

(2) Differences in glide slope intercept altitudes

(3) Two-segment approach

(4) Variation in glide slope

The normal sequence of operations during the test was a takeoff, followed by an approach. It was planned to perform each profile a minimum of six (6) times. This was reduced to three (3) for selected profiles in order to complete the tests in the time available.

ACQUISITION OF OPERATIONAL DATA

The operational data presented herein consist of aircraft performance parameters and tracking data. During the course of each flight operation, photographs of the cockpit instrumentation were made at approximately one-minute intervals. These photographs included, within the field of view, the following instruments and indicators:

(1) Altimeter, pressure and radar

(2) Airspeed indicator

(3) Magnetic Compass

(4) Flight director

(5) Bank and climb indicator

(6) Engine pressure ratio

(7) Exhaust gas temperature

(8) RPM indicator, fan and/or core

(9) Fuel flowmeter

(10) Flap indicators, outboard and inboard

(11) Clock

Standard test procedures required that the test pilots fill out a data sheet for each profile. These data sheets included the nominal gear, flap, speed, and thrust settings, as well as the gross weight and the wind direction, wind velocity, and temperature as reported by the airport tower.

The aircraft altitude and lateral deviation performance were obtained by optically tracking the aircraft. The phototheodolite system installed at the National Aviation Facilities Experimental Center (NAFEC) was used. A detailed description of the equipment and its capabilities is given in Reference 2. The outputs chosen for this program included real-time analog plots, a digital tape of time, X, Y, Z coordinates, and a computer printout of time and slant range to each microphone site. The digital tape, as well as the real-time plots, were referenced to the landing threshold of runway 13.

Every effort was made to track the aircraft out to twelve nautical miles, however, weather conditions were periodically encountered which made this objective difficult to meet. Therefore, some runs do not have tracking data over the outermost noise measurement sites.

TEST AREA

Tests were conducted in the vicinity of NAFEC on 5-30 April 1971. Acoustic data were acquired at eight of the ten surveyed locations on or near the extended centerline of runway 13-31. The coordinate system of the sites in Table IV is referenced to the landing threshold of runway 13. The offset to reference the sites to brake release is the length of the runway, 10,000 feet.

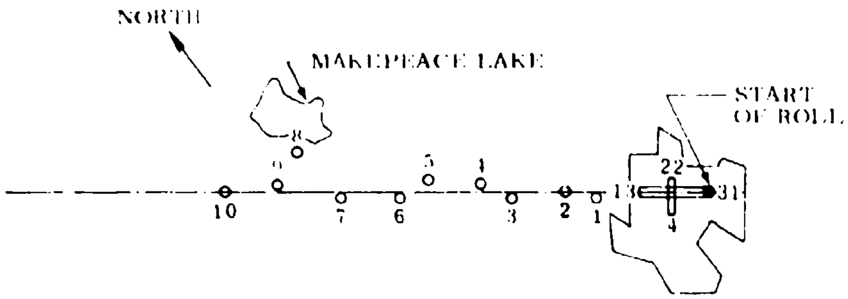
Noise measurements were made throughout the test program at sites 1, 3, 4, 5, 6, 8, and 10. Site 2 was used for all aircraft except some runs of the DC-9 aircraft where the equipment at site 2 was placed at site 9. The site 1 position corresponds to a point 1.0 nautical mile (n.m.) from landing threshold. Site 2 position corresponds to a point 3.5 n.m. from brake release on takeoff.

The terrain off the approach end of runway 13 at NAFEC is a mixture of woods and open fields. Every effort was made to conform to the criteria of Part 36 of the Federal Aviation Regulations (FAR) (Reference 3) in locating the sites. Additional criteria included accessibility to the site and minimizing interference by other noise sources. In most cases, it was possible to locate the microphones virtually underneath the flight path. However, sites 5 and 8 were offset by a distance of 560 feet and 2200 feet, respectively. The dense woods and swampy terrain did not permit the use of site 7.

NOISE MEASUREMENTS

The noise measuring instrumentation used in these tests is shown in Figure 1 and illustrated in the block diagram of Figure 2. The condenser microphones were fitted with windscreens and positioned for grazing incidence at four feet above ground level. The output of each microphone was recorded on a two-channel direct record tape recorder. An IRIG B time code signal

Table IV. Acoustic Measurement Site Coordinates



Referenced to Threshold				Referenced to Brake Release			
Site	X	Y	Z	Site	X	Y	Z
1	-240	6,560	0	1	-240	16,560	0
2	-20	11,240	-11	2	-20	21,240	-11
3	-320	18,760	-8	3	-320	28,760	-8
4	+360	23,300	-10	4	-360	33,300	-10
5	-560	31,000	-11	5	+560	41,000	-11
6	-140	35,200	-11	6	-140	45,200	-11
7	-160	43,970	+2	7	-160	53,970	+2
8	+2200	50,280	-15	8	+2200	60,280	-15
9	+440	53,220	-27	9	+440	63,220	-27
10	0	61,200	-28	10	0	71,200	-28

NOTE: X – Crossrange coordinate
Y – Downrange coordinate
Z – Elevation coordinate

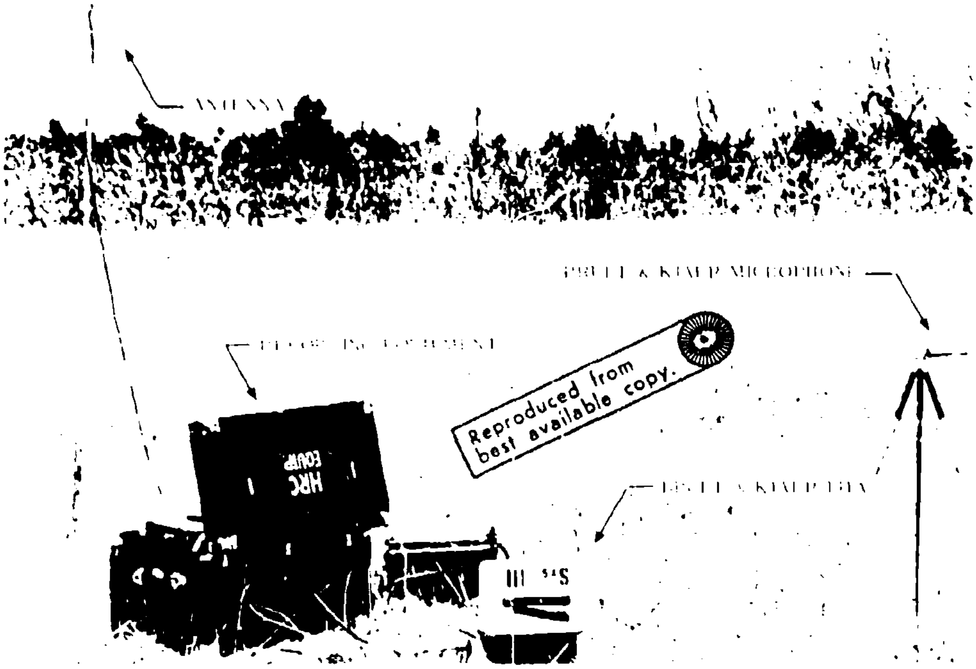


Figure 1. Typical Measurement Site

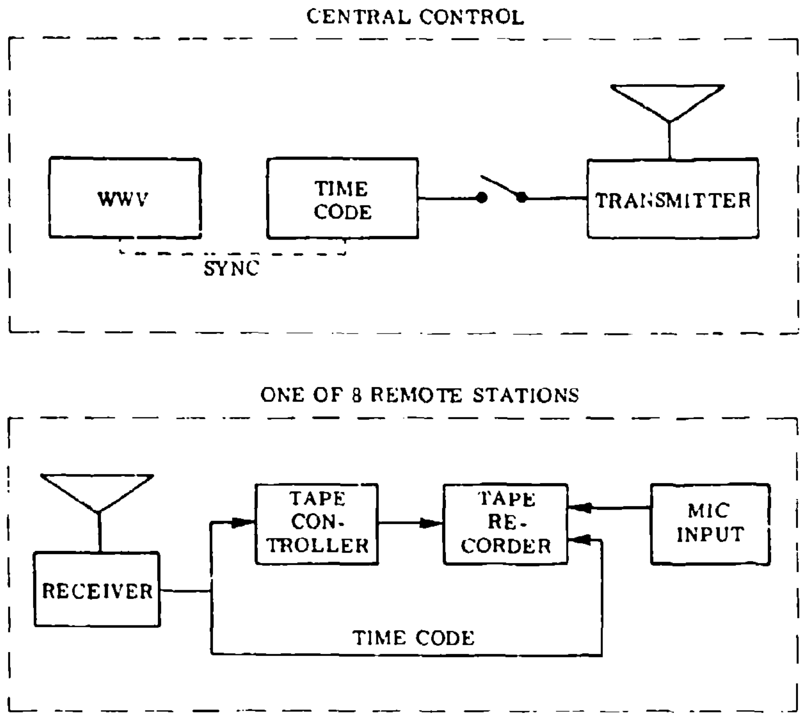


Figure 2. Radio Command Schematic Diagram

transmitted by radio was recorded on the second track. The data recording sequence was controlled by the presence or absence of the IRIG B 1000-cps tone modulating a VHF carrier frequency. A centrally located time code generator and transmitter were keyed on at the start of each run. The radio signal received at each site was used to set and hold a relay which initiated tape motion. Roving field technicians periodically visited each site to check on system performance and to apply a tone calibration to the microphone. The field calibrations included recording an electrical tone at each of the one-third octave band center frequencies and the periodic recording of a 94-dB acoustical calibrator signal at 1000 cps. During these tests, pre-emphasis of the high frequencies was used.

DATA REDUCTION AND ANALYSIS

The analog noise recordings were played back through and processed by the in-house system at San Diego, as shown in Figure 3. This processing system is based on a digital detection technique described in Reference 4. The analog signal is passed by one-third octave band filters whose output are sampled by a multiplexer. The computer converts these samples to engineering values. The total system response was determined by processing the calibration tapes. A typical system response is shown in Figure 4.

Figure 3. HRC In-House Facilities, Model 1360

The system hardware and software conform to the requirements of FAR Part 36, Reference 3. The data were processed in accordance with Part 36, with one exception. This one exception relates to the method of correcting acoustic data to a standard day temperature of 77°F and 70-percent relative humidity. During initial processing of data, it was noticed that for some sites the difference between the uncorrected and the corrected effective perceived noise level was quite large. In certain cases, corrected effective perceived noise levels of over 200 EPNdB were calculated.

Further investigation indicated that these problems occurred when the measured aircraft noise level spectrum was being limited by the background and/or system noise level. For purposes of this discussion, the background noise can be one or a combination of 1) environmental ambient noise, 2) data acquisition system noise, and 3) data processing system noise. A check of the data acquisition and processing systems indicated that the environmental ambient noise was the primary problem. Since a large portion of the data were acquired at distances far in excess of those encountered in a typical noise certification for which Part 36 is designed, an alternate method of applying atmospheric absorption corrections was selected.

The method chosen consists of comparing the spectrum at the time of maximum tone corrected perceived noise level (PNLTM) with the last spectrum acquired in the processing routine. The last spectrum was selected because of its availability at the end of the sound pressure level acquisition routine and except for low frequencies is a good measure of the background noise. When the difference between the spectrum at PNLTM and the background, at frequencies greater than 400 cps, is equal to or less than three decibels, the atmospheric absorption correction consists of the alpha value used for the last band having a signal-to-noise ratio greater than three decibels. The comparison ignores the first ten bands because this noise is attributable to the test aircraft.

A comparison of the uncorrected, the two corrected spectra, and background spectra is given in Figure 5. The tone corrected perceived noise level (PNLT) of the uncorrected spectrum is 87.6 PNdB. When the spectrum is corrected to standard day using ARP 866 (Reference 5), as per Part 36, the PNLT is 118.0 PNdB. The three-decibel signal-to-noise ratio (3-dB S/N) method yields a PNLT of 87.9 PNdB. The PNLT of the background spectrum is 70.5 PNdB. Other methods of solution to this particular problem include the selection of a different signal-to-noise ratio, applying corrections to an extrapolated spectrum and computing PNLT using only those bands above the background.

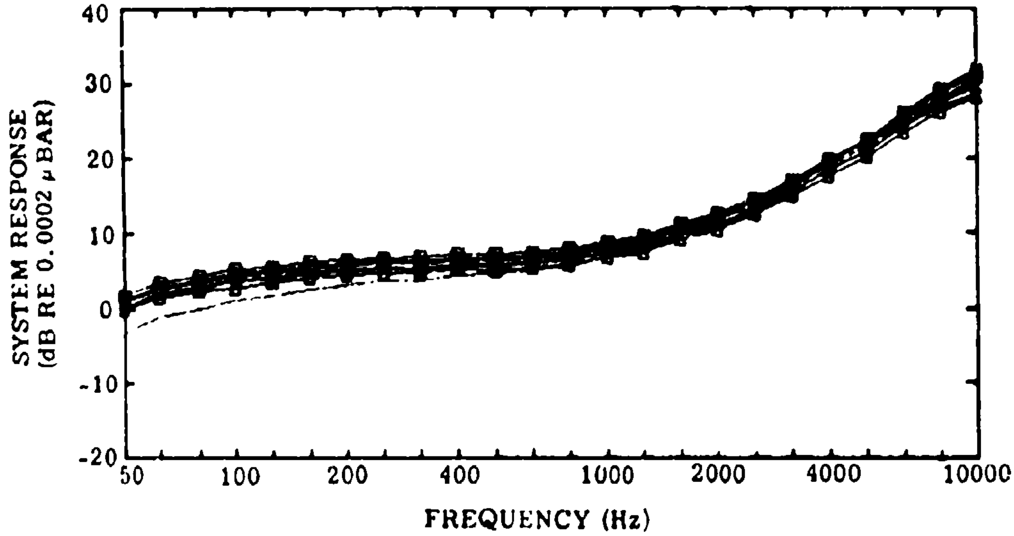


Figure 4. Typical System Frequency Response

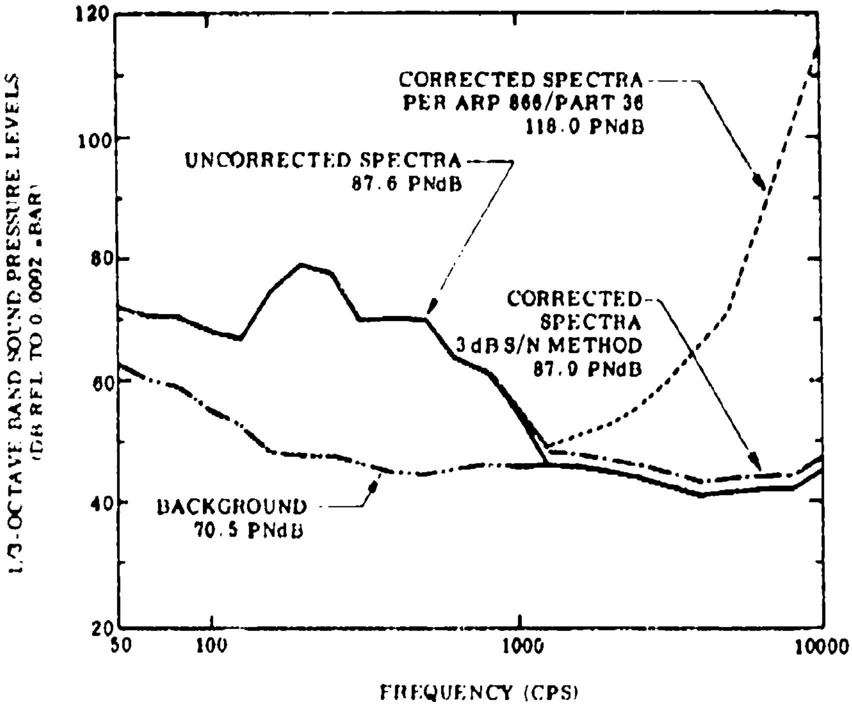


Figure 5. Absorption Correction at PNLTM

For example, select a different signal-to-noise ratio of 5 dB and compare the spectrum at PNLTM with the background. Apply the atmospheric corrections to all bands having a signal-to-noise ratio greater than 5 dB. For all other bands, set the sound pressure level to zero and compute the PNLT of that spectrum. This yields the spectra shown in Figure 6, with a PNLT of 86.0 PNdB.

The spectra in Figure 7 show the results of extrapolating the spectrum at PNLTM and applying the atmospheric absorption corrections as per Part 36. The extrapolation is based on knowledge of the spectrum shape as measured by a much closer microphone. The calculated PNLT of the extrapolated spectrum is 86.4 PNdB. The corrected spectrum in this case has a PNLT of 88.0 PNdB.

The method used to apply the atmospheric absorption correction to data reported herein is offered as only one solution to the problem. The implementation of an accepted universal method awaits further study.

The noise levels presented in this report are effective perceived noise levels corrected to standard day conditions using the 3-dB S/N method, at a distance equal to the aircraft slant range at the time of occurrence of the maximum tone corrected perceived noise level, unless otherwise noted.

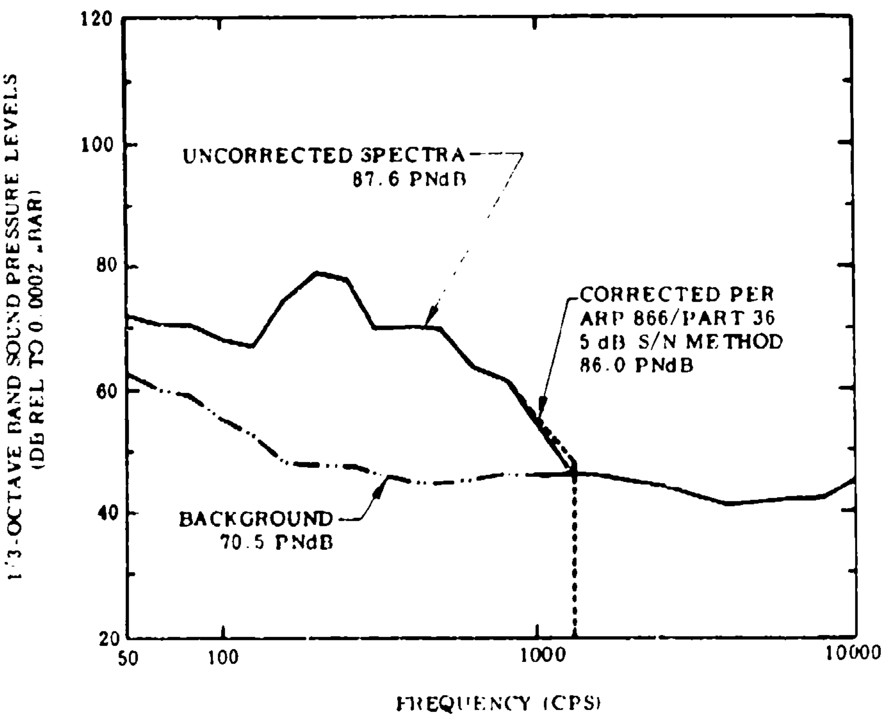


Figure 6. Absorption Correction for 5-dB Signal-to-Noise Ratio

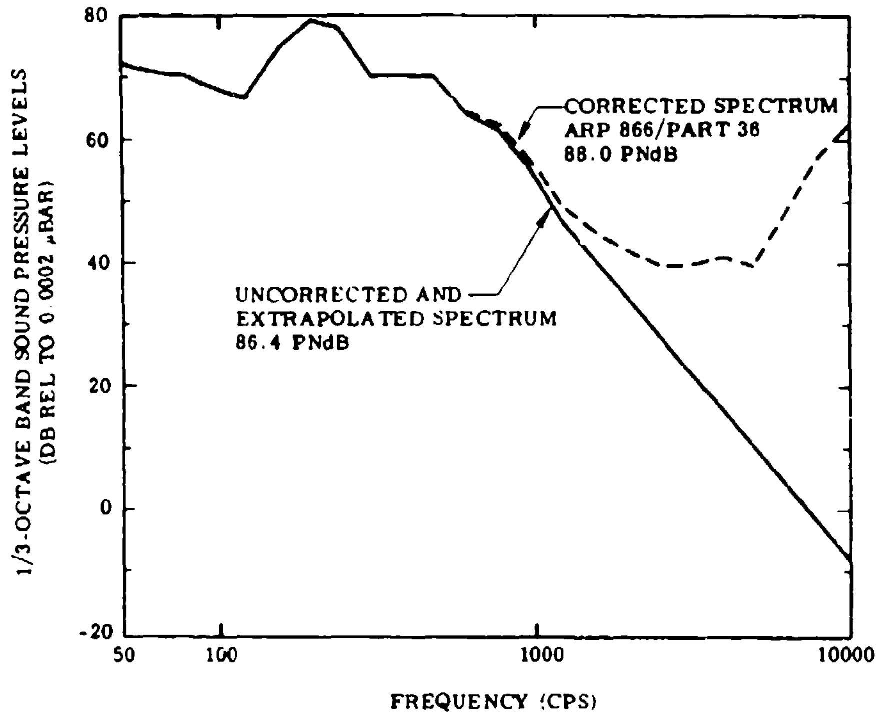


Figure 7. Absorption Correction for Extrapolated Spectrum

ATMOSPHERIC OBSERVATIONS

The meteorological data acquired during the test included surface observations by the airport weather bureau, surface observations at sites 1, 5, and 10, and a limited number of soundings using a weather aircraft. Surface observations included conventional measurements of temperature, wind speed, wind direction, and relative humidity. The wind instrumentation at site 5 was located at 10 meters above the ground.

The weather aircraft soundings included relative humidity measurements during a straight low-level flight over the extended runway centerline and the determination of winds aloft. Winds aloft were determined by flying a fixed heading at a constant true airspeed and tracking the aircraft. The deviation from the planned track in a given time period was used to calculate the wind speed and wind direction. The weather aircraft flew at altitudes of 750, 1500, and 3000 feet above the ground surface to acquire wind information.

Since a large quantity of meteorological data were acquired, the results are contained in two tabulations. The first contains a comparison of wind data and the second a comparison of temperature and relative humidity data. These tabulations are given in Tables V through XII.

The atmospheric absorption corrections were calculated from ARP 866 using the temperature and relative humidity measured by the airport weather bureau.

Table V. Comparison of Wind Data for 727 Aircraft

Date	Time of Day (EST)	Site 1 Wind Vel (kt)	Site 1 Wind Dir (deg)	Site 5 Wind Vel (kt)	Site 5 Wind Dir (deg)	Site 10 Wind Vel (kt)	Site 10 Wind Dir (deg)	Airport Wind Vel (kt)	Airport Wind Dir (deg)	Winds Aloft 1500 Feet Vel (kt)	Winds Aloft 1500 Feet Dir (deg)	Winds Aloft 3000 Feet Vel (kt)	Winds Aloft 3000 Feet Dir (deg)
4-5-71	0600	4G9	80-140	8G16	90-180	6G10	0-90	13	40	23	65		
	0700	5G9	80-140	8G16	90-180	6G14	0-90	15	60				
	0800	5G12	80-140	8G16	90-180	6G11	0-90	16	50	17	112	10	115
	0900	6G14	80-140	8G16	90-180	6G11	0-90	16	70				
	1000	7G14	80-140	8G16	90-180	6G9	0-90	18	70				
	1100	5G13	80-140	8G16	90-180	3G7	0-90	17	60	15	138	9	162
	1200							14	60				
4-7-71	0600	9G17	300-360	5G14		10G16	90-140	17	280				
	0700	8G13	300-360	5G14		10G17	90-140	17	290				
	0800	9G17	300-360	5G14		10G17	90-140	18G	300				
	0900	9G17	300-360	5G14		9G16	90-140	20	300				
	1000	10G16	300-360	5G14		9G16	90-140	15	310				
	1100	8G15	300-360	5G14				15	270				
	1200							10	300				
	1300							12	310	16	285	28	302
4-8-71	0600	3G5	270-300	3G5	270-360	2G3	90-140	7	300	21	292	22	321
	0700	3G5	270-300	5G14	270-360	7G12	90-140	9	300	21	310	34	318
	0800	5G12	270-300	7G17	270-360	10G16	90-140	16G25	310				
	0900	10G17	270-300	9G17	270-360	10G17	90-140	20G25	300				
	1000	12G16	270-360	9G17	270-360	12G19	90-140	18G24	330	23	278	23	310
	1100	11G19	270-360	9G19	270-360	12G19	90-140	15G25	310	16	290		
	1200	11G19	270-360	3G19	270-360			17	320				
4-9-71	0600	1G1	90-180	1G2	260			3	170	15	225	25	275
	0700	1G1	90-180	1G2	260			4	180				
	0800	1G1	90-180	1G2	260			5	200				
	0900	3G5	90-180	1G2	260			5	180				
	1000	3G5	90-180	1G2	260			8	190				
	1100	3G5	90-180	1G2	260			8	190				
	1200							12	180				
4-10-71	0600	10G19	250-300	8G19	270-360			20G	290				
	0700	11G21	250-300	8G19	270-360			20G	300				
	0800	10G19	250-300	8G19	270-360			18G	280				

NOTE: 4G9 = 4 knots average with gusts to 9 knots.

Table VI. Temperature and Relative Humidity Summary for 727 Aircraft

Date	Time of Day (EST)	Site 1		Site 10		Airport		Weather Aircraft	
		Temp (°F)	Rel Hum (%)	Temp (°F)	Rel Hum (%)	Temp (°F)	Rel Hum (%)	Temp (°F)	Rel Hum (%)
4-5-71	0600	60	73	60	63	40	63	34	*
	0700	56	69	62	60	40	60		
	0800	52	62	60	48	43	56		
	0900	50	57	57	38	44	52		
	1000	48	55	55	37	45	52		
	1100	47	57	56	47	45	55		
	1200	46	55	53	47	47	48		
	1300	47	51	52	45	47	48		
	1400	45	51	50	44	47	48		
4-7-71	1300	62	34	40	35	51	42	37-44	*
	1400	60	31	44	33	[illegible]4	27		
	1500	58	28	48	32	55	25		
	1600	56	28	48	30	55	26		
4-8-71	0600	32	55	28	64	32	54	23	*
	0700	44	50	38	52	37	47		
	0800	50	38	50	44	39	39		
	0900	44	34	58	40	41	29		
	1000	45	31	62	38	43	25		
	1100	48	28	62	36	47	24		
	1200	52	25	64	33	48	21		
	1300	66	20	66	31	49	19		
	1400	80	-	74	24	50	17		
	1500	70	-	74	17	52	15		
4-9-71	0600	-	-	-	-	29	79		
	0700	-	-	-	-	39	72		
4-10-71	0600	-	56	-	57	53	54		
	0700	-	55	-	54	50	50		
	0800	-	52	-	53	49	47		
	0900	-	52	-	52	51	44		
	1000	-	50	-	51	51	42		

*Not available

Table VII. Comparison of Wind Data for KC-135 Aircraft

Date	Time of Day (EST)	Site 1		Site 5		Site 10		Airport		Winds Aloft					
										750 Feet		1500 Feet		3000 Feet	
		Wind Vel (kt)	Wind Dir (deg)	Wind Vel (kt)	Wind Dir (deg)	Wind Vel (kt)	Wind Dir (deg)	Wind Vel (kt)	Wind Dir (deg)	Vel (kt)	Dir (deg)	Vel (kt)	Dir (deg)	Vel (kt)	Dir (deg)
4-12-71	0600			1	Var			00	00	0		12	360	25	344
	0700			1	Var			00	00						
	0800			2G3	90			00	00	0		5-14	163-342	25	333
	0900			2G3	90			00	00						
	1000			1G2	90			3	240						
	1100							7	150						
	1200							11	140						
	1300							12	120						
	1400							12	120	0		5	248	2	012
	1500							13	80						
4-13-71	0600	4G7	140-220	0	250	1G1	130-180	00	0	17	248	20	220	20	277
	0700	5G9	140-220	2G3	200	1G1	130-180	00	0						
	0800	5G9	140-220	3G7	180-270	2G3	130-180	11	180	24	190	26	207	26	252
	0900	5G9	140-220	3G7	180-270	3G7	130-180	7	180						
	1000			3G7	180-270	3G7	130-180	10	170						
	1100			3G7	180-270	3G9	130-180	13	180	21	242	15	220	22	214
	1200			5G10	180-270	5G10	130-180	14	180						
	1300			6G12	180-270	6G11	130-180	16	180						
4-15-71	0600	1G1	170	1G2	270-360	1G2	200-260	6	280	24	328	16	332	34	336
	0700	3G5	170	1G2	270-360	3G3		8	280						
	0800	7G9	250-270	3G7	270-360	3G7	200-260	13	290						
	0900	5G9	250-300	5G10	270-360			16	330						
	1000	9G13	250-300	7G14	270-360			14	300						
	1100			5G12	270-360			15	300						
	1200			5G13	270-360			15G23	290						
4-16-71	0600			1G1	250-270	3G5	200-250	7	240	29	315	18	290	18	328
	0700			1G2	250-270	9G17	220-270	8	250						
	0800					9G17	220-270	13	290						
	0900					10G17	220-260	20	300						
	1000							19G24	300						
	1100							21G	290						
	1200							19	270						

NOTE: 4G7 - 4 knots average with gusts to 7 knots.

Table VIII. Temperature and Relative Humidity Summary for KC-135 Aircraft

Date	Time of Day (EST)	Site 1		Site 10		Airport		Weather Aircraft	
		Temp (°F)	Rel Hum (%)	Temp (°F)	Rel Hum (%)	Temp (°F)	Rel Hum (%)	Temp (°F)	Rel Hum (%)
4-12-71	0600	34	82	37	82	30	79	44	79
	0700	48	86	44	75	36	78		
	0800	53	53	48	60	47	65	48-49	53-59
	0900	56	43	62	48	51	54		
	1000	60	37	65	34	56	43		
	1100	68	32	64	48	57	45		
	1200	69	37	64	21	54	54	51-64	57-17
	1300	71	42	65	18	55	45		
	1400	72	35	66	34	55	49		
	1500	80	37	65	34	56	47		
	1600	96	42	64	34	56	42	56-57	35-41
	1700	-	-	-	-	54	47		
4-13-71	0600	36	80	42	79	35	88	43-48	52-80
	0700	56	86	44	82	43	86		
	0800	66	76	54	70	52	56		
	0900	69	45	62	42	57	40		
	1000	72	27	70	26	60	36		
	1100	74	22	70	21	62	28		
	1200	-	21	-	16	-	-		
	1300	-	17	-	13	-	-		
4-15-71	0600	34	60	36	63	33	45	36	40
	0700	42	73	42	53	37	40		
	0800	47	55	46	45	39	34		
	0900	48	45	48	38	43	24		
	1000	50	37	50	35	44	23		
	1100	53	28	52	32	47	23		
	1200	55	-	54	29	49	21		
	1300	-	-	56	28	51	21		
	1400	-	-	57	27	52	20		
	1500	-	-	58	26	53	19		
	1600	-	-	64	25	52	17		
	1700	-	-	66	24	52	29		
4-16-71	0600	38	67	42	63	39	63	41-44	33-46
	0700	40	69	46	61	41	55		
	0800	48	56	54	45	49	35		
	0900	52	42	56	38	51	32		
	1000	60	36	60	30	53	24		
	1100	78	29	72	-	55	23		

Table IX. Comparison of Wind Data for 707-320B Aircraft

Date	Time of Day (EST)	Site 1 Wind Vel (kt)	Site 1 Wind Dir (deg)	Site 5 Wind Vel (kt)	Site 5 Wind Dir (deg)	Site 10 Wind Vel (kt)	Site 10 Wind Dir (deg)	Airport Wind Vel (kt)	Airport Wind Dir (deg)	Winds Aloft 750 Feet Vel (kt)	Winds Aloft 750 Feet Dir (deg)	Winds Aloft 1500 Feet Vel (kt)	Winds Aloft 1500 Feet Dir (deg)	Winds Aloft 3000 Feet Vel (kt)	Winds Aloft 3000 Feet Dir (deg)
4-19-71	0600	6G10		2G3	270-360	5G9	250-270	10	340	32	346	32	035	20	355
	0700	6G10		3G9	270-360	6G10	260-280	13	340	6	015	18	002	26	085
	0800	7G12	270-360	5G13	0-90			11	360						
	0900			5G13	0-90	6G10	270-270	15G20	360						
	1000			7G16	0-90			12G18	350			14	348	14	055
	1100			7G16	0-90			13G20	10						
	1200			6G16	0-90	7G12	260-300	14G21	330						
4-20-71	0600			1G3	0-45	3G7	280-300	8	350	21	360	23	053	27	002
	0700			3G8	300-90			8	360	9	007	20	357	25	059
	0800			5G10	300-90	5G9	270-300	11	360						
	0900			5G10	300-90	6G10	270-300	10	350						
	1000			4G10	300-90			8	330	8	360	24	355	2	012
	1100			5G12	300-90	7G12	240-300	7	340						
	1200			5G12	300-90	7G12	240-300	12	320						
4-21-71	0600	3G7	180-270	2G5	230-300			8	250	24	290	15	248	24	275
	0700	5G9	180-260					8	260	17	232	26	288	20	223
	0800	5G9	170-250			7G12	200-240	13	250						
	0900	5G9	170-250			10G14	200-240	14	240						
	1000					10G16	190-230	15	240						
	1100					12G14	190-240	15	240						
	1200					10G16	180-240	17	230						
4-22-71	0600	4G9	230-300	2G5	270-300	3G5	200-250	6	260	29	310	19	320	34	324
	0700	7G13	230-300	5G9	270-360	5G10	220-260	11	280						
	0800	12G19	230-300	5G10	270-360	9G16	230-270	16	280						
	0900			7G14	270-360	10G17	200-280	20	300	20	292	31	322	22	300
	1000			8G16	270-360			21	300						
	1100			8G17	270-360			20	320						
	1200							19	300						

NOTE: 6G10 = 6 knots average with gusts to 10 knots.

Table X. Temperature and Relative Humidity Summary for 707-320B Aircraft

Date	Time of Day (EST)	Site 1 Temp (F)	Site 1 Rel Hum (%)	Site 10 Temp (F)	Site 10 Rel Hum (%)	Airport Temp (F)	Airport Rel Hum (%)	Weather Aircraft Temp (F)	Weather Aircraft Rel Hum (%)
4-19-71	0600	48	56	55	48	42	56	48-50	42
	0700	56	53	60	43	50	41		
	0800	62	47	64	42	50	43	54	39
	0900	65	44	66	42	58	37		
	1000	67	44	68	42	61	33		
	1100	70	42	70	40	64	30	59-61	33-35
4-20-71	0600	48	66	44	72	47	58	48-49	49-61
	0700	56	63	54	50	52	48	54	41
	0800	64	51	64	42	56	38		
	0900	67	42	66	36	60	34		
	1000	69	39	68	33	62	28		
	1100	72	32	70	29	63	24	60	26-29
4-21-71	0600	52	71	54	64	49	71	50	65
	0700	58	68	60	51	54	59	48	68
4-22-71	0600	44	61	50	57	43	51	45	50
	0700	50	58	54	52	48	45		
	0800	56	52	58	49	51	42		

Table XI. Comparison of Wind Data for DC-9 Aircraft

Date	Time of Day (EST)	Site 1 Wind Vel (kt)	Site 1 Wind Dir (deg)	Site 5 Wind Vel (kt)	Site 5 Wind Dir (deg)	Site 10 Wind Vel (kt)	Site 10 Wind Dir (deg)	Airport Wind Vel (kt)	Airport Wind Dir (deg)	Winds Aloft 750 Feet Vel (kt)	Winds Aloft 750 Feet Dir (deg)	Winds Aloft 1500 Feet Vel (kt)	Winds Aloft 1500 Feet Dir (deg)	Winds Aloft 3000 Feet Vel (kt)	Winds Aloft 3000 Feet Dir (deg)
4-27-71	0600	2G5	300	1G2	290-330			8	300	26	155	29	195	26	195
	0700	5G9	280-315	3G7	300-360			11	320						
	0800			5G13	310-360	5G10	250-300	13	340	19	165	15	140	19	190
	0900	7G14	290-360	5G10	330-60	6G9	250-300	12	350						
	1000	7G12	290-360	4G9	330-60	5G9	250-300	9	350						
	1100			3G7	350-90	3G7	250-300	8	330						
	1200			3G9	270-90			9	330	2	160	12	155		
	1300			3G7	300-90			6	250						
	1400			3G7	300-90			12	180						
	1500			3G9	300-90	4G9	220-300	12	180						
	1600					4G7		8	160						
4-28-71	0500							10	200						
	0600	3G7	130-200					10	190	27	215	25	185	21	210
	0700			3G5	170-260	2G3	140	10	180						
	0800	4G10	150-210	4G9	170-260	3G6	140	12	180	33	195	18	245	36	205
	0900			3G9	170-250			10	190						
	1000	5G10	130-200	4G9	160-270			10	180						
	1100			3G9	150-250			7	170						
	1200							8	160	12	145			37	210
4-30-71	0500							5	250						
	0600							5	300						
	0700							5	310						
	0800							5	300						
	0900	4G8	250-300			2G5	220-300	7	330	7	075	12	340	4	115
	1000			3G9		3G5	250-320	4	50						
	1100					3G5	200-260	7	280						
	1200					3G7	180-250	9	210	6	140	18	310	8	030
	1300							8	210						
	1400							4	260						

NOTE: 2G5 2 knots average with gusts to 5 knots.

Table XII. Temperature and Relative Humidity Summary for DC-9 Aircraft

Date	Time of Day (EST)	Site 1 Temp (°F)	Site 1 Rel Hum (%)	Site 10 Temp (°F)	Site 10 Rel Hum (%)	Airport Temp (°F)	Airport Rel Hum (%)	Weather Aircraft Temp (°F)	Weather Aircraft Rel Hum (%)
4-27-71	0600	34	75	34	81	36	74	44	69
	0700	42	81	40	82	39	72		
	0800	52	82	50	68	45	63		
	0900	56	60	53	52	50	52	48	52
	1000	60	51	56	48	53	44		
	1100	64	47	60	44	54	41		
	1200	65	43	60	40	-	-	54	38
	1300	66	39	64	35	56	35		
	1400	70	34	66	31	57	34		
	1500	74	33	66	30	58	34		
4-28-71	0600	44	69	50	70	49	66	49	63-66
	0700	50	64	50	69	51	52		
	0800	52	60	52	65	55	52		
	0900	52	57	54	61	50	50	50-52	51-59
	1000	54	59	56	58	51	56		
	1100	54	60	56	54	50	63		
4-30-71	0900	60	48	60	40	47	68		
	1000	60	57	58	50	52	56		
	1100	58	50	60	43	55	51		

DISCUSSION OF RESULTS

AIRCRAFT PERFORMANCE

The performance of the aircraft during the takeoff-climbout and landing-approach operations is indicated by the tabulated results in Tables XIII through XVI for the aircraft tested. These values were obtained from the pilot test cards for each segment of a given profile.

The resultant altitude profile and lateral deviation track of each operation is given in the appendixes for each aircraft. These tracking plots were obtained by plotting a value every ten seconds from the phototheodolite digital tape. The digital data did contain some errors in tracking. However, all obvious errors have been omitted from the tracking plots.

In order to compare the effectiveness of the various operational procedures, the test results in the appendixes are compared with appropriate reference curves obtained from References 6 and 7. The flight reference curves are those that would normally be used to predict the aircraft noise for the appropriate weight during straight out departures and a 3-degree glide slope on approach with intercept of the glide slope at 1500- and 3000-foot altitude. The particular reference profiles superimposed upon the test data are indicated in Table XVII, Table XVIII, and Figure 8. The reference profile is identified as SAE A, B, C or D, as appropriate for takeoffs.

A review of the test data in Appendixes A, B, C, and D indicate a difficulty in achieving flight track repeatability, particularly on takeoff-climbout operations. Especially large excursions in lateral deviation from the planned flight tracks are noted in Figures A-4, A-8, A-12, A-52, A-56, B-12, B-20, B-28, C-4, D-36, and D-56.

ATMOSPHERIC OBSERVATIONS

Summaries of the prevailing meteorological conditions are given in Tables V through XII for the four aircraft tested. The absence of homogeneity in the surface winds over the test area should be noted. In addition, the large change in wind velocity and direction, as a function of altitude, should be noted. In general, the airport weather bureau reported the highest wind speeds. The measurements at sites 1 and 5 are considered to be local wind since the sites were located in open fields surrounded by woods. Low altitude runs by the weather aircraft resulted in pilot comments about severe wind currents when going from open to forested terrain.

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Table XIII. Summary Performance Parameters, 727 Aircraft

Profile Number	Aircraft Weight (lb)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)
		SEGMENT A-B			SEGMENT B-C			SEGMENT C-D			SEGMENT 3000 FEET		
T1	125-139,000		2.01	15	250	2.01	Clean	250	1.87	Clean	250	1.43-1.90	Clean
T2	120-138,000	150-158	1.98-2.01	15	150-158	1.51	15	150-158	1.51	15			
T3	124-138,000	143-148	1.96	15	200	1.96	Clean	200	1.38-1.43	Clean			
T4	124-139,000	152-159	1.96-1.97	15	152-159	1.82-1.84	15	152-159	1.82-1.84	15			
T5	140-159,000	153-157	1.95	15	250	1.95	Clean	250	1.81-1.82	Clean			
T6	124-157,000	162-166	1.95	15	162-166	1.51	15	162-166	1.51	15			
T7	123-139,000	151-159	1.96	15	151-159	1.51	5	151-159	1.51	5			
		SEGMENT F-D			SEGMENT D-E								
A11A	131-134,000	150	1.30	15	126	1.43-1.80	40						
A11B	122,000	160	1.25-1.30	5	121-126	1.45-1.50	40						
A12	124-157,000	150	1.30	15	133-139	1.20-1.55	30						
A13	121-125,000	150	1.30	15	135-142	1.15-1.20	15						
		SEGMENT A-H			SEGMENT H-E								
A21	115-135,000	131	1.30-1.50	15	121-140	1.50-1.60	40						
		SEGMENT A-I			SEGMENT I-E								
A31	126-137,000	150	1.30	15	126-132	1.40-1.50	40						
		SEGMENT A-C			SEGMENT C-G			SEGMENT G-E					
A41	125-136,000	150	1.30	15	123-126	1.10-1.25	40	123-126	1.35-1.50	40			
		SEGMENT A-B			SEGMENT B-E								
A51	127-137,000	150	1.30	15	127-132	1.30-1.50	40						

Table XIV. Summary Performance Parameters, KC-135 Aircraft

Profile Number	Aircraft Weight (lb)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)
		SEGMENT A-B			SEGMENT B-C			SEGMENT C-D			SEGMENT 3000 FEET		
T1	163-185,000	155-167	2.55-2.65	20	250	2.45-2.53	Clean	250	2.40-2.45	Clean			
T2	165-192,000	169-178	2.40-2.52	20	169-178	2.00-2.10	20	169-178	2.00-2.10	20			
T3	165-190,000	168-151	2.45-2.60	20	190-220	2.45-2.60	Clean	220-230	2.00-2.40	Clean	250	Climb Thrust 2.57	Clean
T4	158-190,000	166-178	2.46-2.48	20	166-178	2.40-2.42	20	166-178	2.40-2.42	20			
T5	209-222,000	167-175	2.55	20	250	2.50-2.55	Clean	250	2.50	Clean			
T6	205-218,000	175-183	2.55	20	175-183	2.00	20	175-183	2.00	20			
		SEGMENT F-D			SEGMENT D-E								
A11A	160-182,000	145-163	1.55-1.75	30	139-148	1.59-1.85	50						
A12	162-175,000	155-160	1.4[illegible]-1.60	30	145-150	1.40-1.49	40						
A13	160-187,000	156-165	1.50-1.70	30	156-165	1.38-1.50	30						
		SEGMENT A-H			SEGMENT H-E								
A21	170-190,000	156-166	1.67-1.75	30	141-151	1.52-1.71	50						
A22	150-188,000	150-165	1.45-1.80	30	140-161	1.40-1.65	40						
A23	163-187,000	155-165	1.55-1.70	30	155-165	1.40-1.60	30						

Table XV. Summary Performance Parameters, 707-320B Aircraft

Profile Number	Aircraft Weight (lb)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)
		SEGMENT A-B			SEGMENT B-C			SEGMENT C-D			SEGMENT 3000 FEET		
T1	200-219.000	160 var	1.84 1.61- 1.85 1.82	14	180-250	1.84 1.81- 1.85 1.82	Clean	250	1.68-1.72	Clean			
T2	201-225.000	157-162	1.83 1.80- 1.84 1.82	14	155-160	1.22 1.22- 1.24 1.24	14	155-160	1.22-1.24	14			
T3	205-220.000	142-150	1.84 1.81- 1.85 1.81	14	150-190	1.84 1.81- 1.85 1.81	Clean	189-230	1.24	Clean	250	1.72	Clean
T4	193-218.000	150-160	1.84 1.84	14	157-162	1.71 1.71- 1.72 1.72	14	150-162	1.72-1.75	14			
T5	301-315.000	175-178	1.85 1.85	14	178-210	1.68 1.68- 1.85 1.85	(14) Clean	240-250	1.65-1.68	Clean			
T6	298-309.000	170-185	1.85 1.85	14	180-195	1.35 1.35- 1.39 1.39	14	175-185	1.35-1.39	14			
T8	210-218.000	158-160	1.84 1.84	14	162-170	1.60 1.60	14	170-250	1.72	Clean			
		SEGMENT F-D			SEGMENT D-E								
A11A	209-218.000	150-160	1.20-1.22	25	130-138	1.25-1.26	50						
A11B	198-205.000	156-160	1.16-1.17	14	130-135	1.23-1.24	50						
		SEGMENT A-H			SEGMENT H-E								
A21	198-218.000	133-160	1.12-1.40	25	135-140	1.16-1.32	50						
A22	207-215.000	140-156	1.18-1.32	25	132-152	1.20-1.21	40						
A23	185-214.000	144-172	1.18-1.25	25	132-150	1.14-1.20	25 (50 at 500')						
		SEGMENT A-I			SEGMENT I-E								
A31	183-201.000	146-153	1.21-1.28	25	129-130	1.16-1.18	50						
		SEGMENT A-C			SEGMENT C-G			SEGMENT G-E					
A41	189-214.000	155-175	1.19-1.22	25	138-148	1.10-1.20	50	136-142	1.18-1.22	50			
		SEGMENT A-B			SEGMENT B-E								
A51	175-212.000	145-158	1.20-1.35	25	128-146	1.18-1.22	50						

Table XVI. Summary Performance Parameters, DC-9 Aircraft

Profile Number	Aircraft Weight (lb)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)	Speed (kt)	Engine Pressure Ratio	Flap (deg)
		SEGMENT A-B			SEGMENT B-C			SEGMENT C-D			SEGMENT 3000 FEET		
T1	72-75,000	141-154	1.94	20	200-220	1.84-1.94	Clean	230-250	1.80-1.83	Clean	230-250	1.82-1.86	Clean
T2	71-74,000	147-156	1.94	20	150-157	1.59	20	149-157	1.59	20			
T3	67-76,000	134-142	1.94	20	146-182	1.94	Clean	170-182	1.59	Clean			
T4	70-79,000	150-156	1.94	20	146-155	1.85-1.88	20	150-158	1.86-1.88	20			
T5	81-85,000	150-152	1.94	20	180-190	1.94	Clean	240-245	1.85-1.86	Clean			
		SEGMENT F-D			SEGMENT D-E								
A11A	70-72,000	153-154	1.24-1.25	20	127-130	1.32-1.35	50						
A11B	66-69,000	162-163	1.18-1.20	10	126-128	1.28-1.32	50						
A12	78-83,000	152-155	1.35-1.42	30	145-156	1.22-1.25	30						
		SEGMENT A-H			SEGMENT H-E								
A21	73-80,000	156-162	1.20-1.32	20	131-137	1.35-1.40	50						
A22	69-77,000	153-164	1.21-1.31	20	135-143	1.19-1.24	30						
A23	67-75,000	151-160	1.22-1.24	20	150-160	1.18-1.21	20 (50 at 500')						
		SEGMENT A-I			SEGMENT I-E								
A31	64-78,000	150-163	1.22-1.28	20	125-138	1.25-1.37	50						
		SEGMENT A-C			SEGMENT C-G			SEGMENT G-E					
A41	67-80,000	153-162	1.24-1.30	20	130-142	1.14-1.28	50	128-136	1.26-1.40	50			
		SEGMENT A-B			SEGMENT B-E								
A51	71-78,000	156-162	1.20-1.27	20	129-135	1.38-1.40	50						

Table XVII. Reference Profiles Related to Operational Procedures, Takeoff

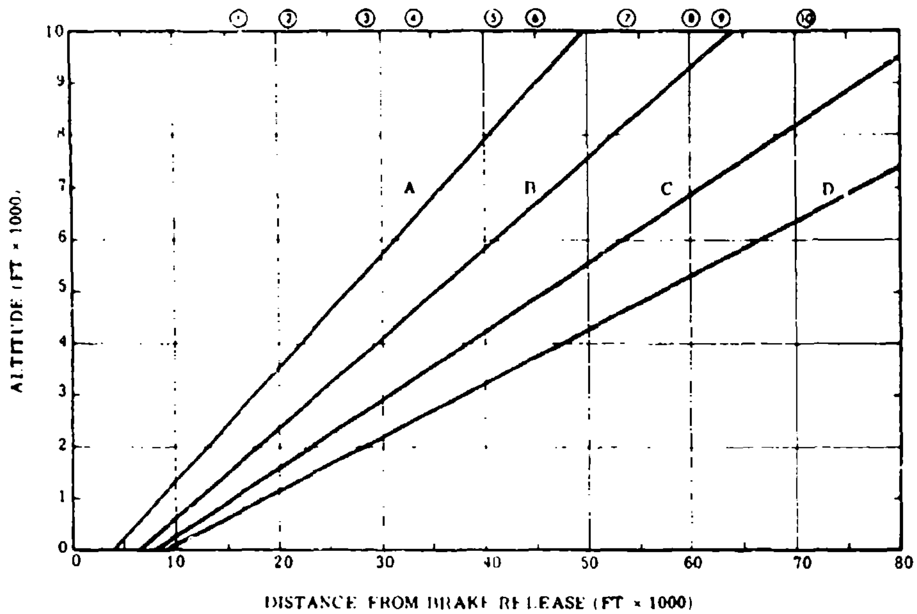
Aircraft	Takeoff Procedure	Test Weight (1000 lb)		AIR 1114 Profile	
		Minimum	Maximum	Specified	Use for Reference
727	T1	125	139	B-C	C
	T2	120	138	B-C	C
	T3	124	138	B-C	C
	T4	124	139	B-C	C
	T5	140	159	C-D	D
	T6	124	157	B-C-D	D
	T7	123	139	B-C	C
	T8	NA*	NA	NA	NA
KC-135	T1	163	185	B	B
	T2	165	192	B	B
	T3	165	190	B	B
	T4	158	190	B	B
	T5	209	222	B-C	C
	T6	205	218	B-C	C
	T7	NA	NA	NA	NA
	T8	NA	NA	NA	NA
707-320B	T1	200	219	A-B	B
	T2	201	225	A-B	B
	T3	205	220	A-B	B
	T4	193	218	A-B	B
	T5	301	315	D	D
	T6	298	309	D	D
	T7	NA	NA	NA	NA
	T8	210	218	A-B	B
DC-9	T1	72	75	A	A
	T2	71	74	A	A
	T3	67	76	A	A
	T4	70	79	A	A
	T5	81	85	A	A
	T6	NA	NA	NA	NA
	T7	NA	NA	NA	NA
	T8	NA	NA	NA	NA

*NA - not applicable

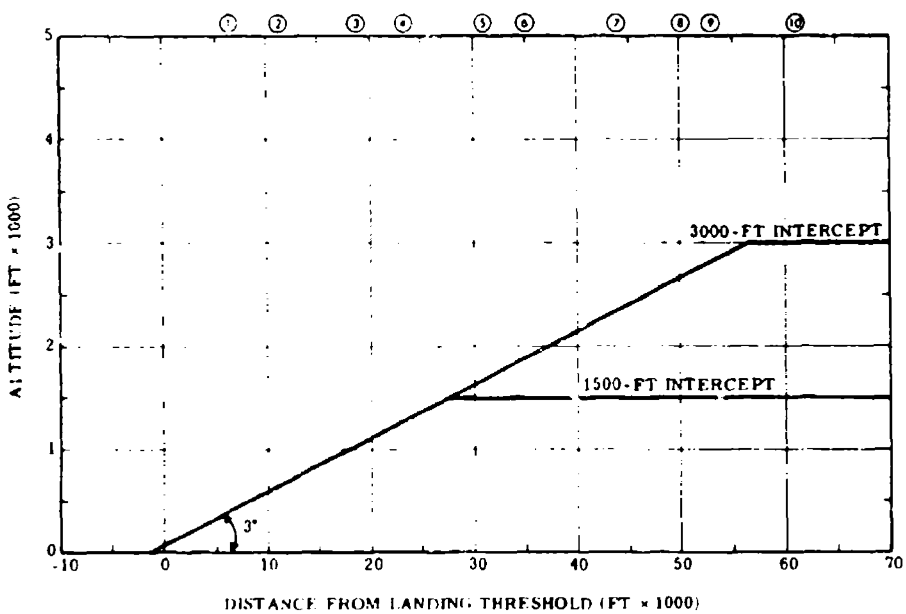
Table XVIII. Reference Profiles Related to Operational Procedures, Approach

Aircraft	Approach Procedure	Test Weight (1000 lb)		Reference Profile	
		Minimum	Maximum	Angle (deg)	Intercept (ft)
727	A11A	131	134	3	1500
	A11B	NA*	122	3	1500
	A12	124	157	3	1500
	A13	121	125	3	1500
	A21	116	135	3	3000
	A22	NA	NA	NA	NA
	A23	NA	NA	NA	NA
	A31	126	137	3	3000
	A41	125	136	3	3000
	A51	127	137	3	3000
KC-135	A11A	160	183	3	1500
	A11B	NA	NA	NA	NA
	A12	162	175	3	1500
	A13	160	187	3	1500
	A21	170	190	3	3000
	A22	150	188	3	3000
	A23	163	187	3	3000
	A31	NA	NA	NA	NA
	A41	NA	NA	NA	NA
	A51	NA	NA	NA	NA
707-320B	A11A	209	218	3	1500
	A11B	198	205	3	1500
	A12	NA	NA	NA	NA
	A13	NA	NA	NA	NA
	A21	198	218	3	3000
	A22	207	215	3	3000
	A23	185	214	3	3000
	A31	183	201	3	3000
	A41	189	214	3	3000
	A51	175	212	3	3000
DC-9	A11A	70	72	3	1500
	A11B	66	69	3	1500
	A12	78	83	3	1500
	A13	NA	NA	NA	NA
	A21	73	80	3	3000
	A22	69	77	3	3000
	A23	67	75	3	3000
	A31	64	78	3	3000
	A41	67	80	3	3000
	A51	71	78	3	3000

*NA - not applicable



a. Takeoff



b. Approach

Figure 8. Reference Flight Profiles

Considering the extended area covered by the sites, the agreement of temperature and relative humidity appears reasonable.

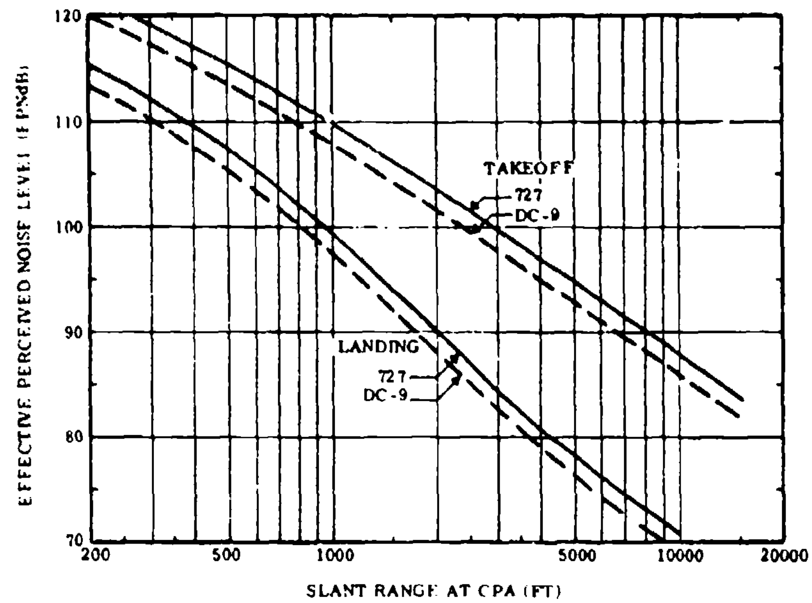
NOISE MEASUREMENTS

The results of the noise measurements obtained during the takeoff-climbout and landing-approach tests of the 727-100, KC-135A, 707-320B, and DC-9-10 are presented in Appendixes A, B, C, and D. These results are in the form of effective perceived noise level as a function of distance from brake release or landing threshold and effective perceived noise level as a function of slant range at the closest point of approach (CPA) between the flight path and the microphone. All data were corrected to a temperature of 77°F and a relative humidity of 70 percent. The symbols on these figures (see Figures A-1 and A-2 for examples) are the effective perceived noise level in EPNdB measured at each site for all flyovers of a given profile. The site numbers are given across the top of Figure A-1. The spread of data in Figure A-1 is representative of the repeatability of the noise level at each location. Data scatter at any site can be attributed to variations in aircraft altitude, lateral deviation, aircraft performance parameters, and experimental error. By plotting the effective perceived noise level as a function of slant range at CPA, as in Figure A-2, variations attributable to aircraft altitude and lateral deviation should be smoothed out. The corresponding reference noise levels were obtained from References 6 and 7 and are shown in Figure 9. These noise reference curves represent the current state of the art in noise prediction. For reference curve purposes, the KC-135 aircraft is assumed to be equivalent to a 707-320 aircraft without a jet suppressor. As shown in Figure 9b, the noise curve for the KC-135 has been raised 5 dB to compensate for the lack of a suppressor. These data are superimposed on the appropriate noise versus slant range test data.

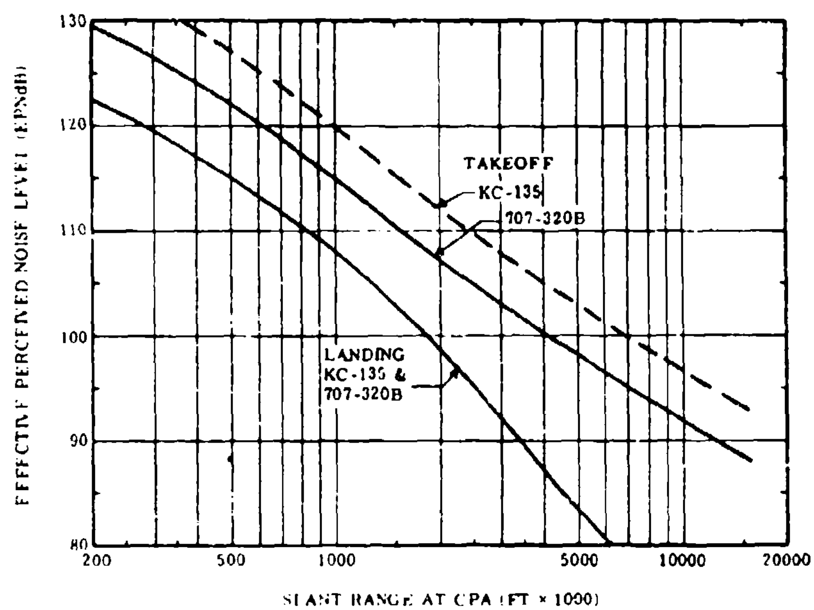
The data from Figures 8 and 9 were used to construct the reference noise level curves as given in Figure 10. These curves are superimposed upon the appropriate noise versus distance test data plots.

A comparison of the reference curves and the test data can be made to determine the noise reduction of the various operational procedures. Additionally the differences between the real and the idealized situation are highlighted.

During the course of the test, instrumentation problems were encountered which required additional measures to retrieve the data. In particular, the recorded time code at site 5 was at times impossible to recover. In order to recover the data, these runs were processed to yield an EPNL uncorrected for atmospheric absorption since it was not possible to obtain the time of PNLTM and therefore the slant range. Next, correction factors for absorption were computed by taking the difference between EPNLC (corrected to

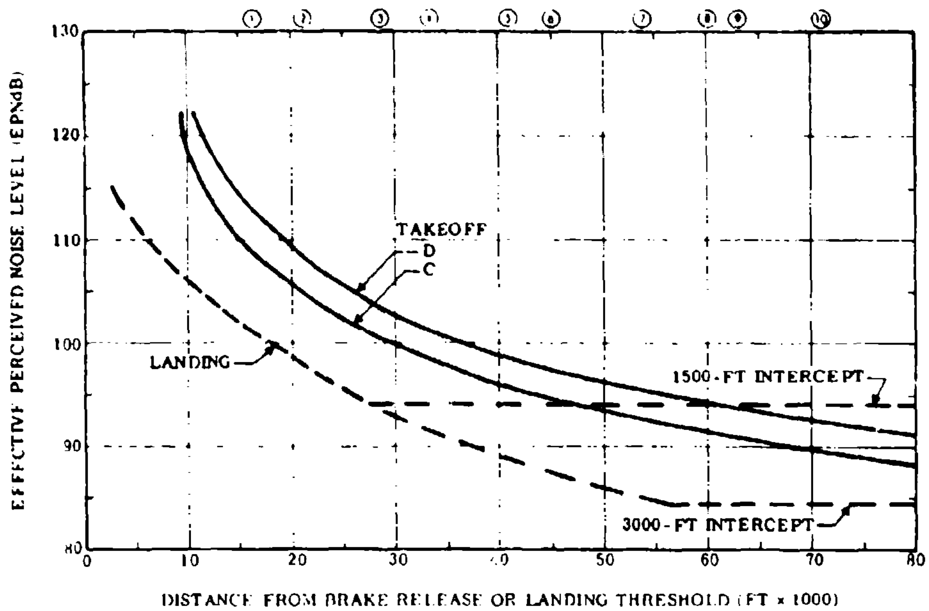


a. 727 and DC-9 Aircraft

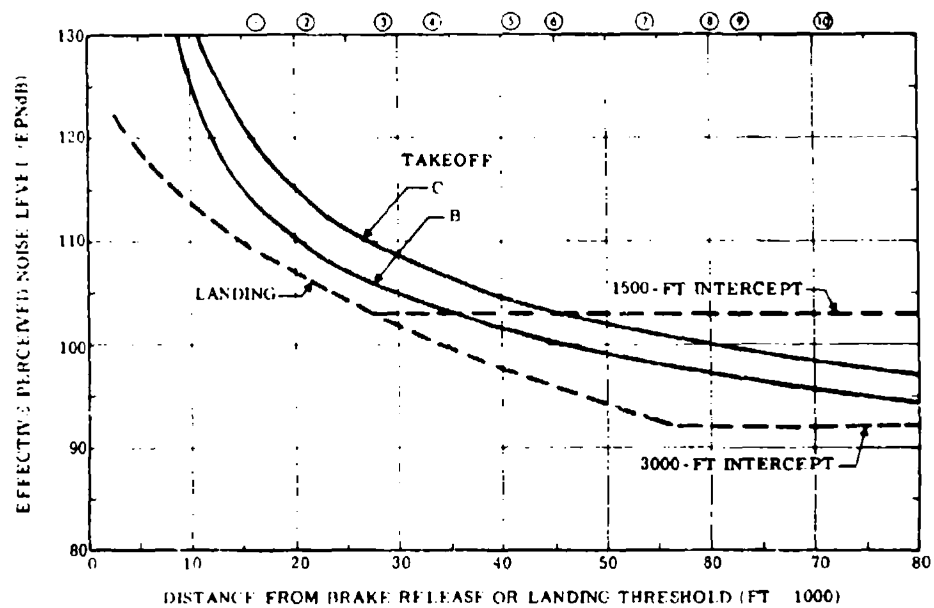


b. KC-135 and 707-320B Aircraft

Figure 9. Reference Noise Levels as a Function of Slant Range

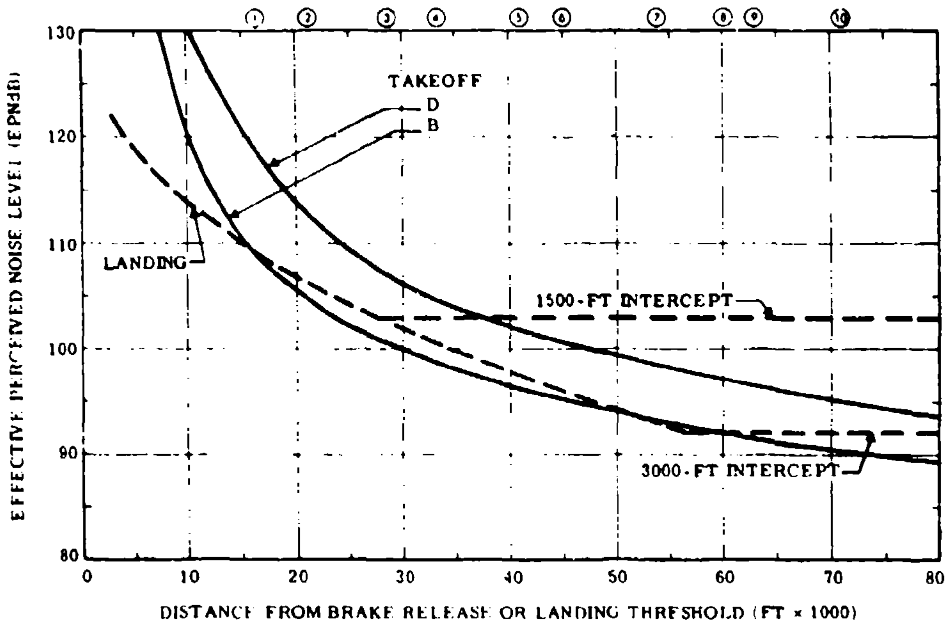


a. 727 Aircraft

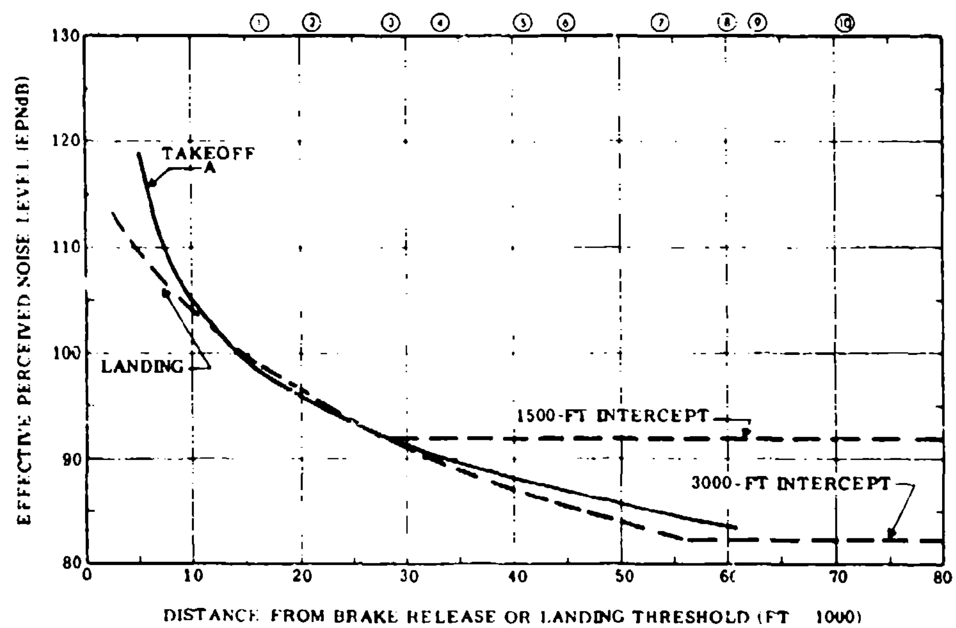


b. KC-135 Aircraft

Figure 10. Reference Noise Levels as a Function of Distance



c. 707-320B Aircraft



d. DC-9 Aircraft

Figure 10. Reference Noise Levels as a Function of Distance, Contd

standard day) and EPNLU (uncorrected for standard day) for sites 4 and 6 of the same runs. These corrections were then added to the site 5 uncorrected EPNL to obtain the plotted corrected EPNL.

In general, the data repeatability of individual data points is reasonable. However, rather excessive data spreads do occur as is illustrated in Figures A-37 and A-41 for the 727 aircraft. For these particular runs, data were obtained on two separate days. It is to be noted from the weather summary given on the figures that wind speed for the square symbols is 25 knots. Although considerable variations occur for sites 1 through 6, the data at sites 8 and 10 show differences on the order of 10 EPNdB. These variations are attributed to two items. First, the low frequency contribution of wind noise on the one-inch microphones used at these locations is a factor. At the higher wind speed, it is felt that the windscreen simply cannot counteract the turbulent eddies generated over the large microphone grid. Second, and more importantly, stabilization of engine thrust over the outer stations occurred at different locations from one day to the next.

CONCLUSIONS

Detailed comparisons of noise from the tested profiles indicate that two general conclusions can be drawn from the tests. First, an optimum noise abatement procedure for takeoff can yield worthwhile noise reductions. Second, a two-segment approach can achieve significant reductions in noise along the ground.

Several factors encountered during the course of these tests, the data processing and data evaluation, have highlighted the need for a reevaluation of the respective techniques involved. First, the basic criteria of testing in wind velocities of less than 10 knots was not always possible to follow. Obviously, from the summaries of the wind data given in Tables V, VIII, XI, and XIV, a question arises as to the best location for wind measurement. In the cases presented, the most adverse wind conditions, in general, existed aloft over that portion of the atmosphere through which the sound propagates. In view of the large range of existing wind conditions in excess of 10 knots and the possible affect of these winds on the aircraft performance, the acoustic data show surprising stability.

The method of applying the atmospheric absorption correction to standard day temperature and relative humidity was discussed earlier in this report. The method used to apply the correction for data presented in this report is not necessarily the best solution. However, it is certainly necessary to device a methodology to apply to those cases where portions of the spectrum at PNLTM are coincident with the background levels. This is especially important when data must be corrected for absorption at humidities less than 30 percent.

The variations in the individual data groups are, in some cases, significant even when six samples are considered. The largest variations occurred at sites 8 and 10; however, for the most part data standard deviation is less than ±2 dB. This deviation exceeds that specified in FAR Part 36, but is considered to be reasonable based on the conditions encountered during the tests.

The results presented for the 727, KC-135, 707-320B, and DC-9 aircraft provide detailed noise and tracking data for the determination of noise from standard and noise abatement operational techniques. Additionally, the data can be utilized to improve the state of the art of aircraft noise prediction.

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2. "Range Instrumentation Environment," Volume II, Federal Aviation Administration - National Aviation Facilities Experimental Center, June 1969.

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4. E. M. Fitzgerald, A. A. Petrini, and J. K. Zimmerman, "Real-Time Spectrum Analysis in the Field Using a General Purpose Computer," Hydrospace Research Corporation Technical Report, November 1969.

5. "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity for Use in Evaluating Aircraft Flyover Noise," Society of Automotive Engineers, Aerospace Recommended Practice (ARP) Report Number 866, 31 April 1970 (Proposed).

6. "Procedures for Developing Aircraft Noise Exposure Contours Around Airports," Society of Automotive Engineers Air 1114, March 1970 (Proposed).

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Appendix A

727 AIRCRAFT
DETAILED NOISE AND TRACKING PLOTS

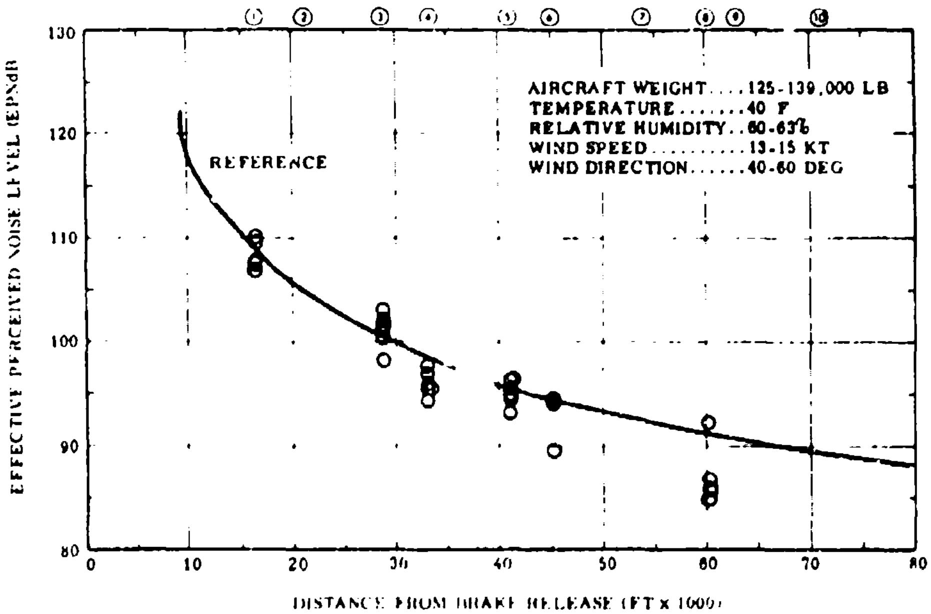

Figure A-1. Takeoff Noise Levels for Profile T1, 727 Aircraft

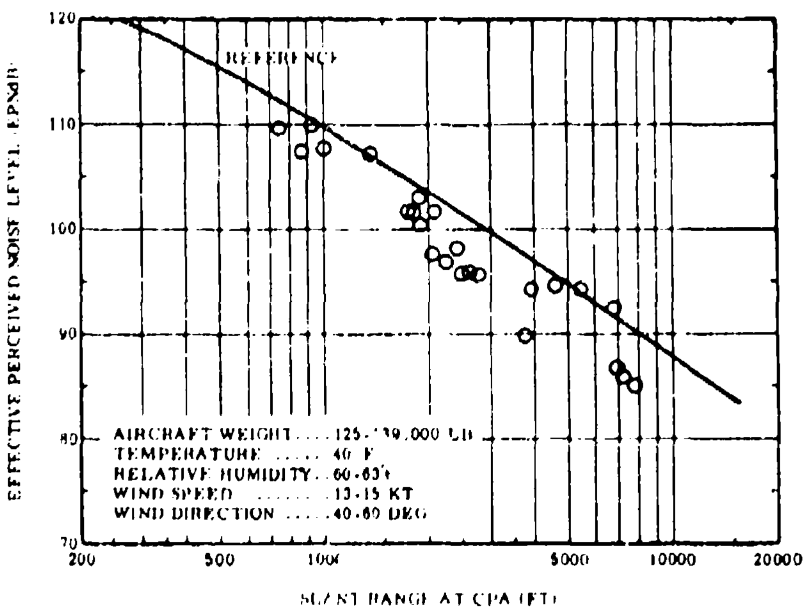

Figure A-2. Noise Levels as a Function of Slant Range for Profile T1, 727 Aircraft

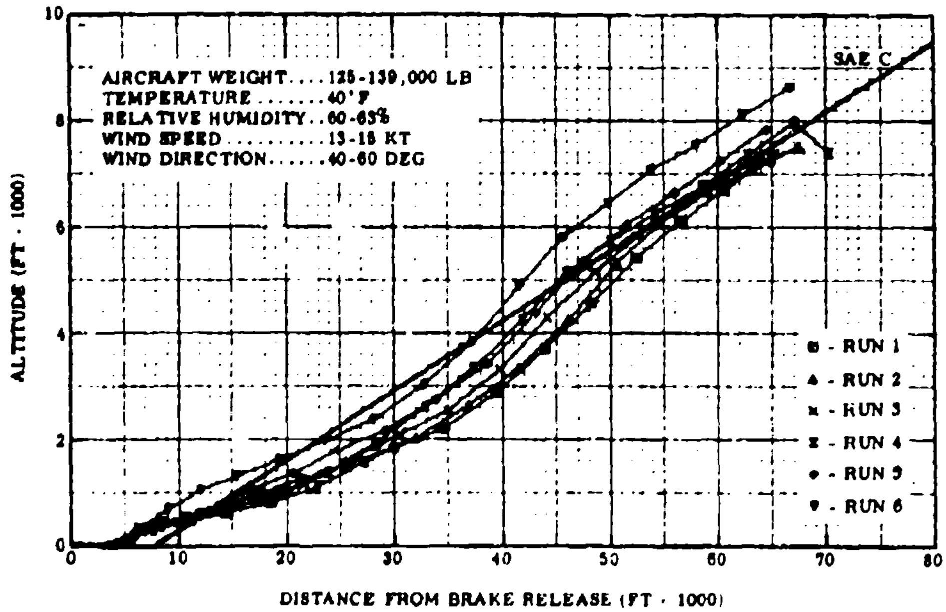

Figure A-3. Takeoff Profile T1, 727 Aircraft

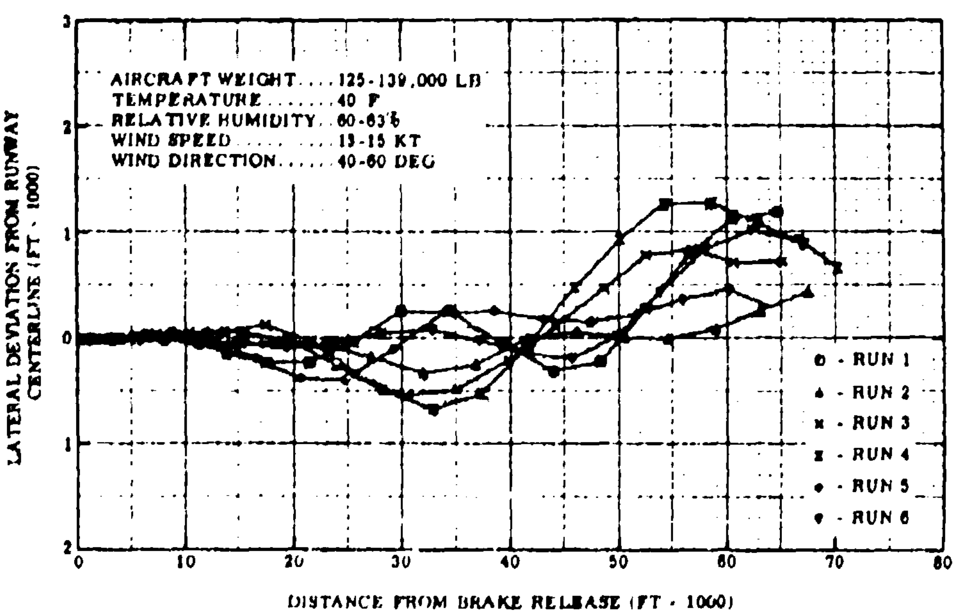

Figure A-4. Takeoff Lateral Deviation T1, 727 Aircraft

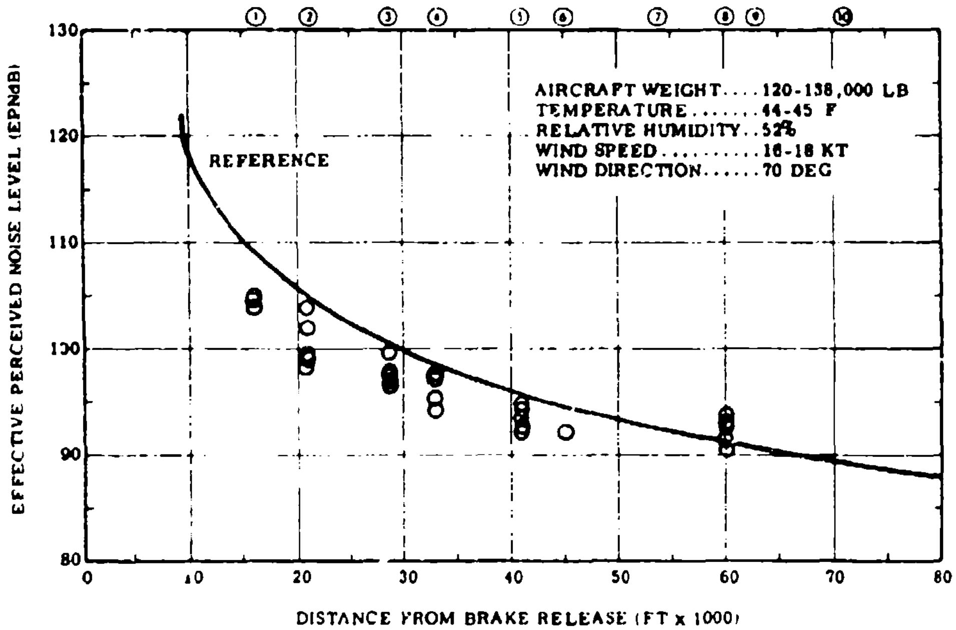

Figure A-5. Takeoff Noise Levels for Profile T2, 727 Aircraft

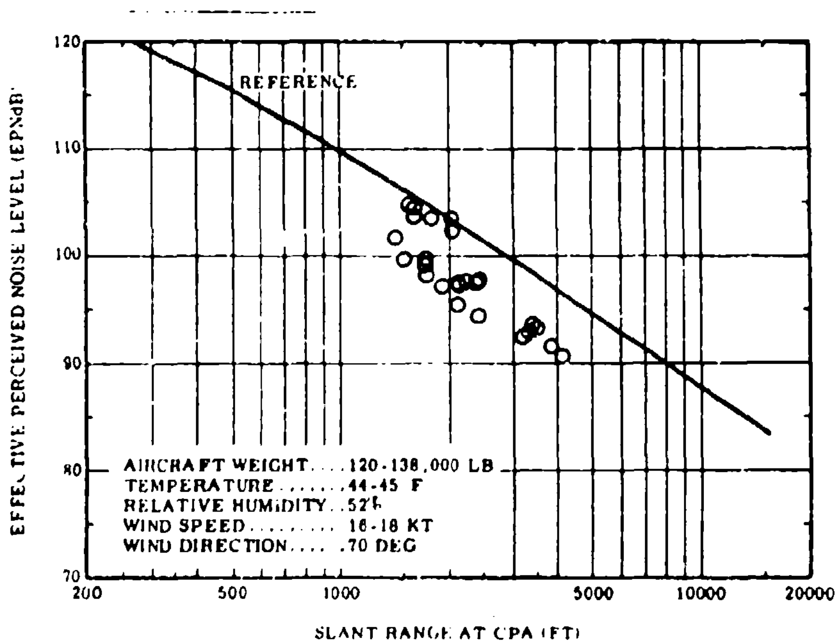

Figure A-6. Noise Levels as a Function of Slant Range for Profile T2, 727 Aircraft

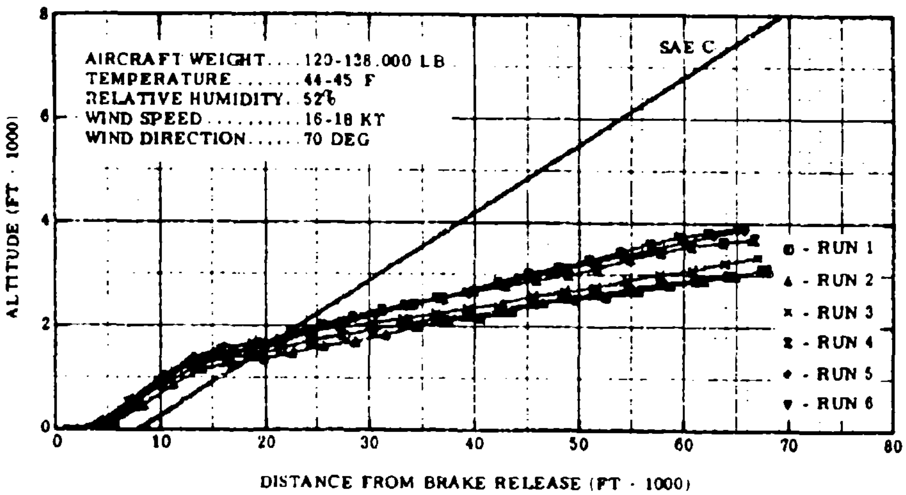

Figure A-7. Takeoff Profile T2, 727 Aircraft

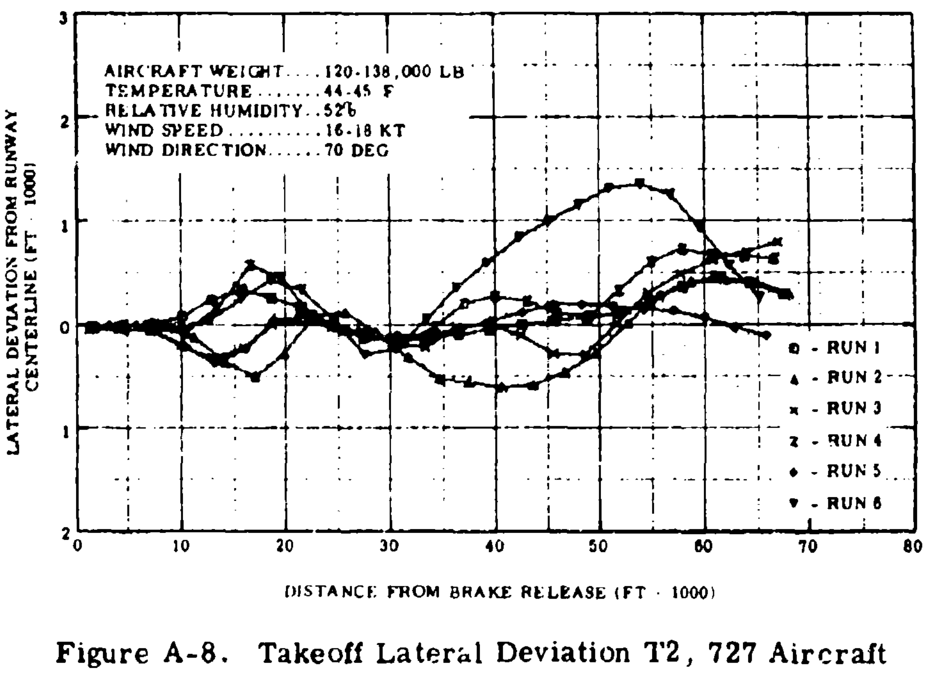

Figure A-8. Takeoff Lateral Deviation T2, 727 Aircraft

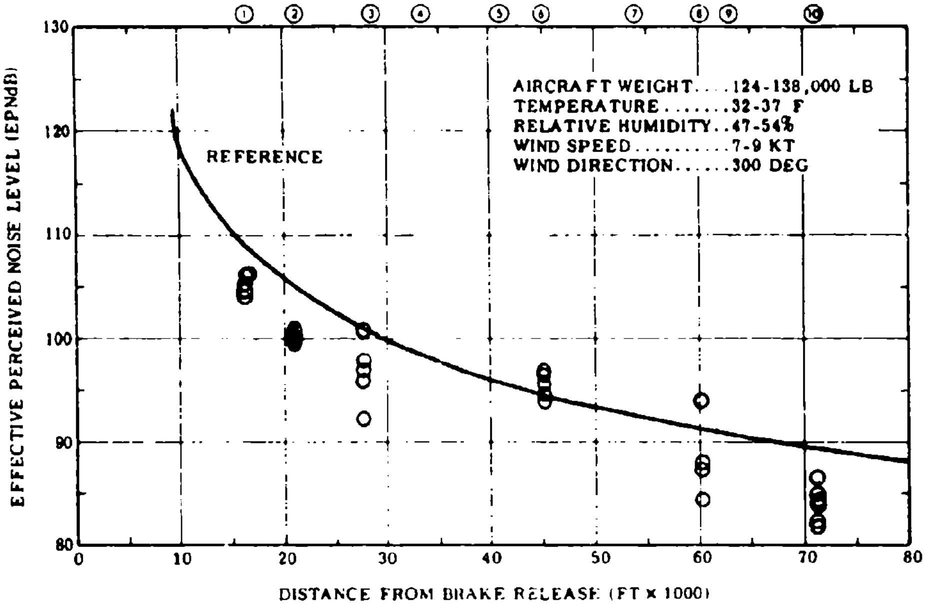

Figure A-9. Takeoff Noise Levels for Profile T3, 727 Aircraft

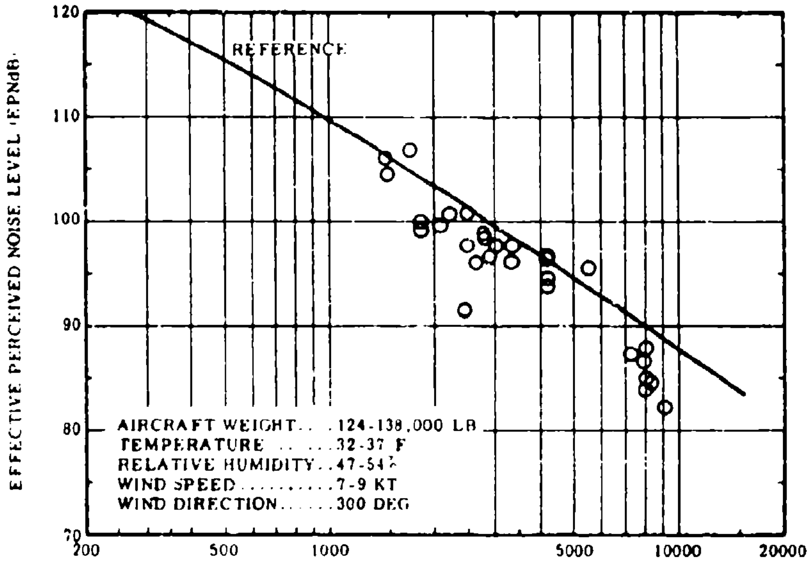

Figure A-10. Noise Levels as a Function of Slant Range for Profile T3, 727 Aircraft

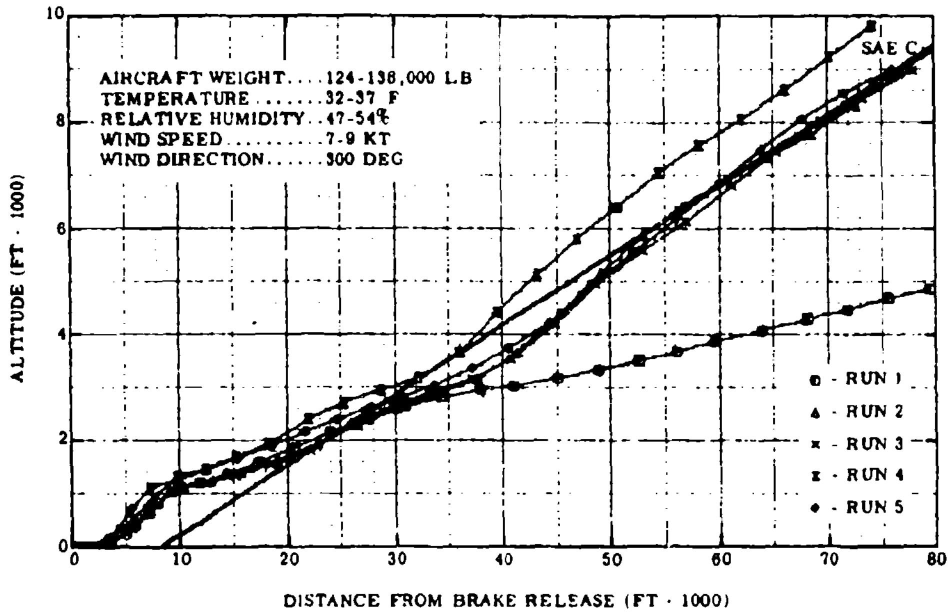

Figure A-11. Takeoff Profile T3, 727 Aircraft

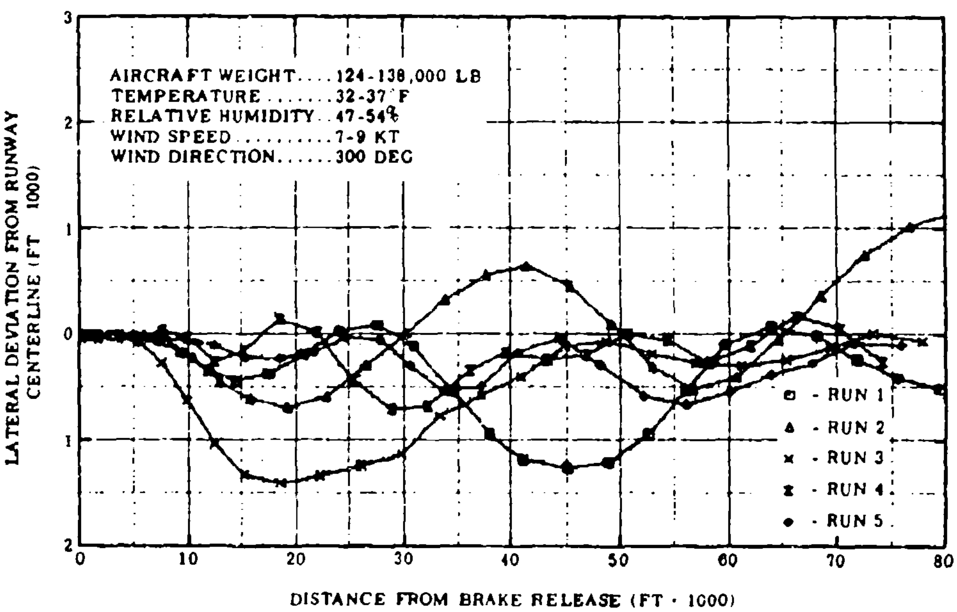

Figure A-12. Takeoff Lateral Deviation T3, 727 Aircraft

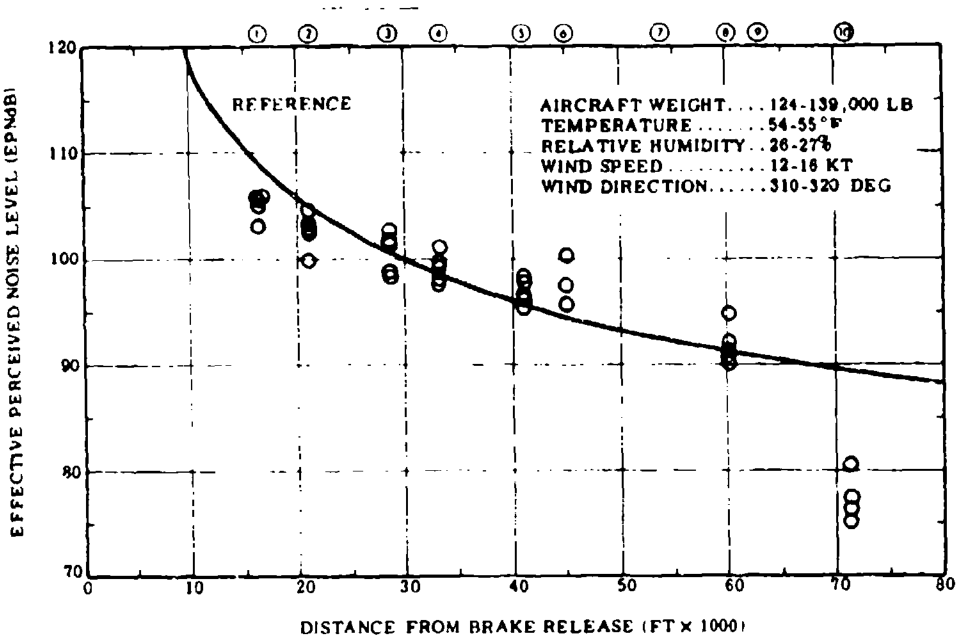

Figure A-13. Takeoff Noise Levels for Profile T4, 727 Aircraft

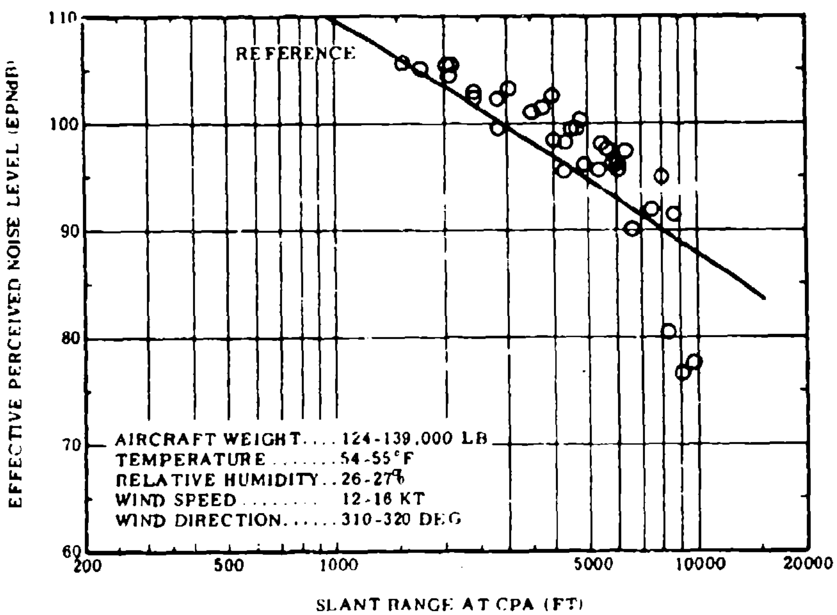

Figure A-14. Noise Levels as a Function of Slant Range for Profile T4, 727 Aircraft

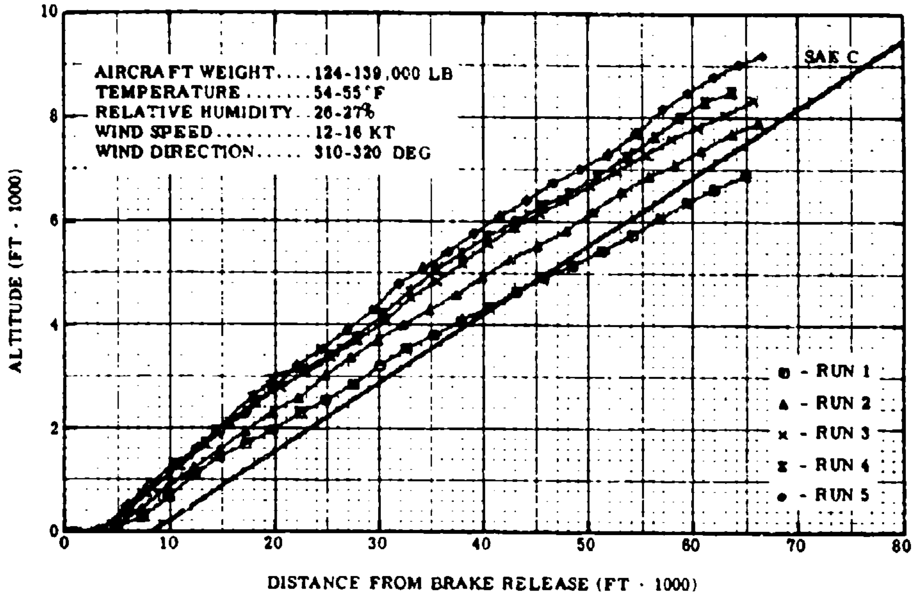

Figure A-15. Takeoff Profile T4, 727 Aircraft

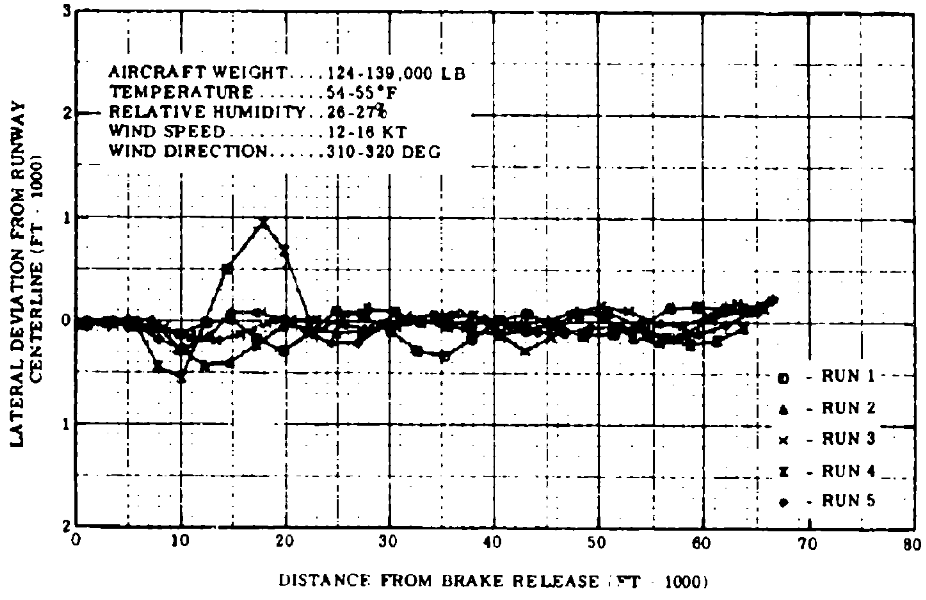

Figure A-16. Takeoff Lateral Deviation T4, 727 Aircraft

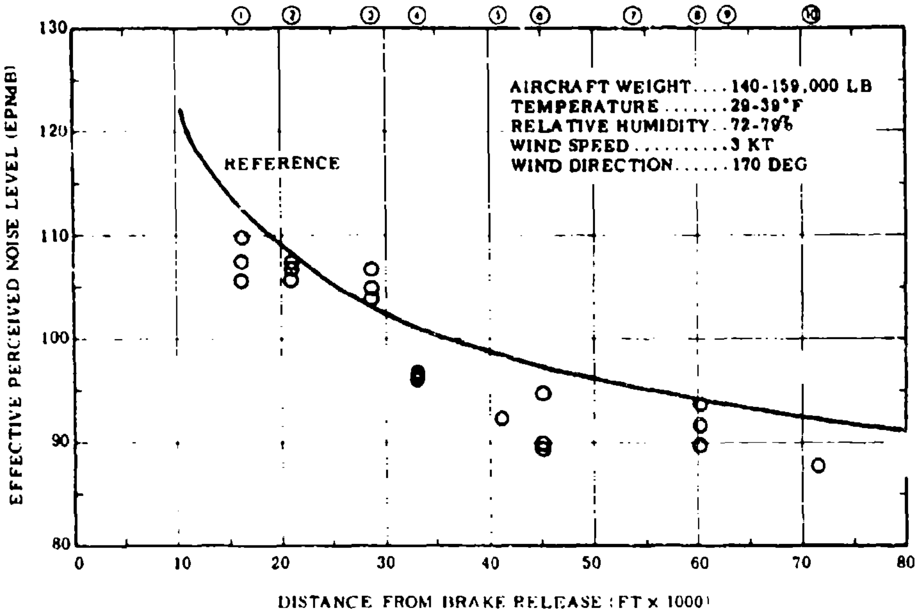

Figure A-17. Takeoff Noise Levels for Profile T5, 727 Aircraft

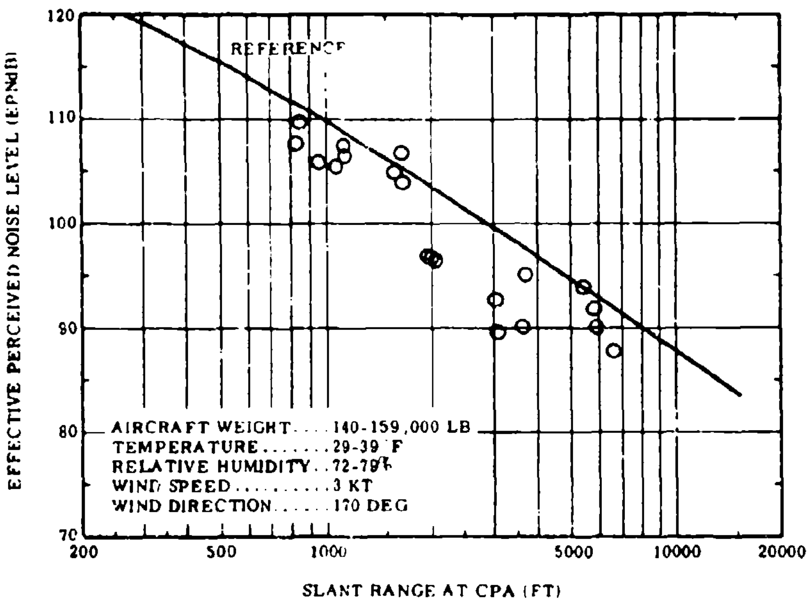

Figure A-18. Noise Levels as a Function of Slant Range for Profile T5, 727 Aircraft

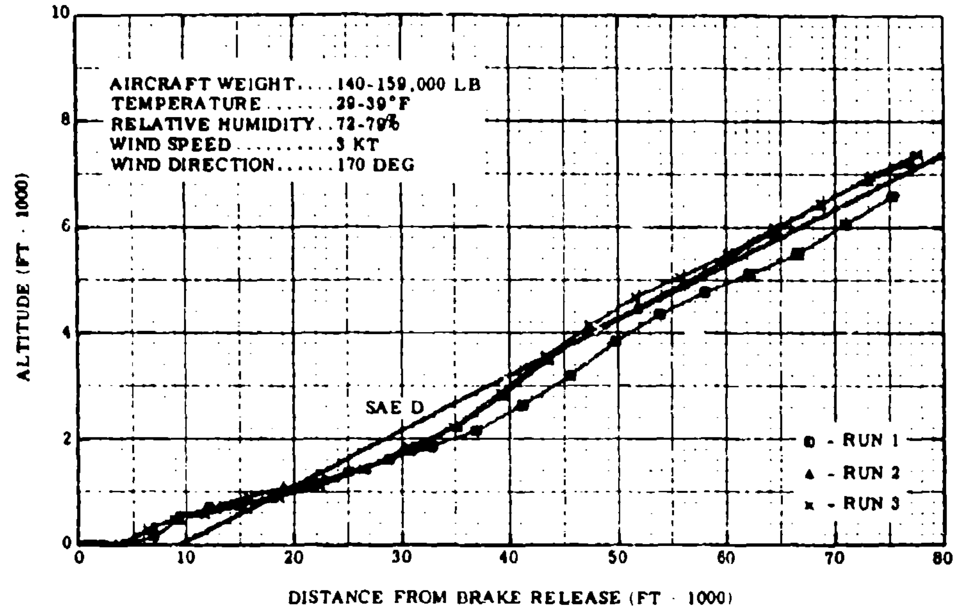

Figure A-19. Takeoff Profile T5, 727 Aircraft

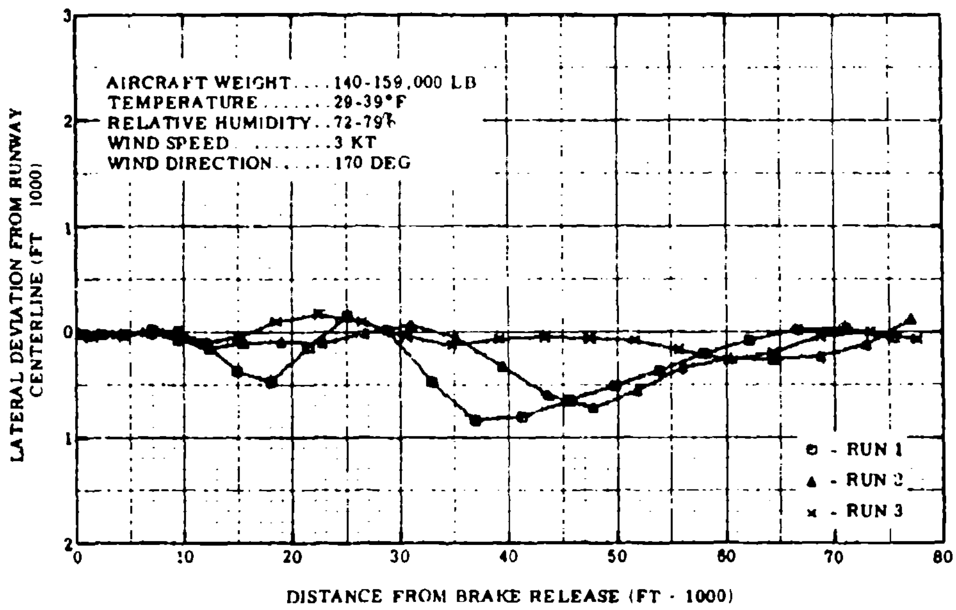

Figure A-20. Takeoff Lateral Deviation T5, 727 Aircraft

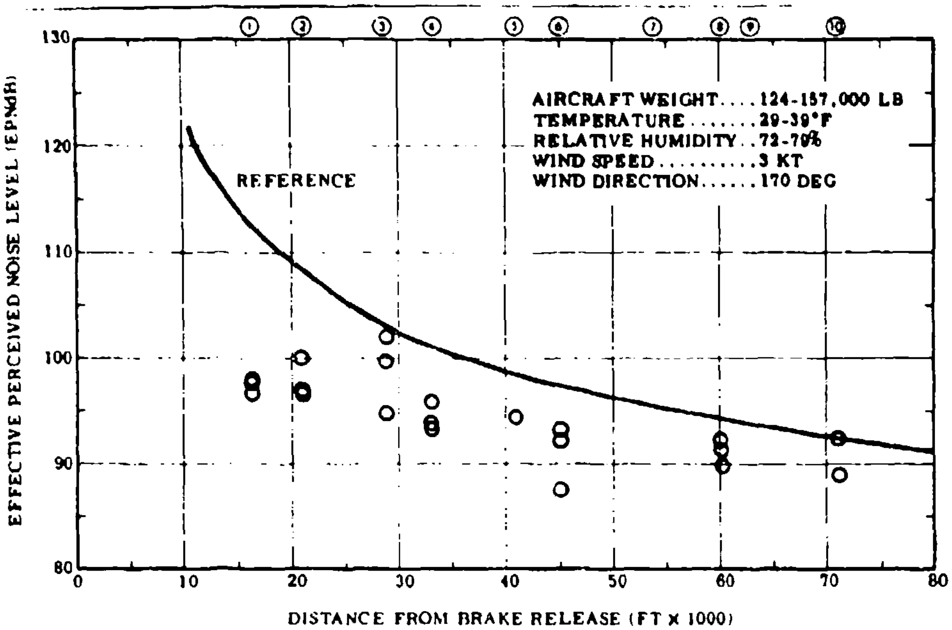

Figure A-21. Takeoff Noise Levels for Profile T6, 727 Aircraft

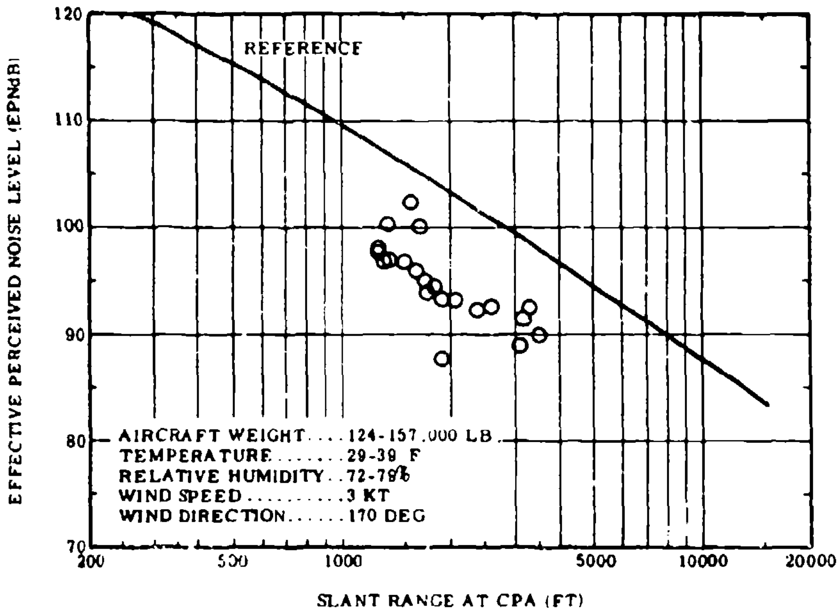

Figure A-22. Noise Levels as a Function of Slant Range for Profile T6, 727 Aircraft

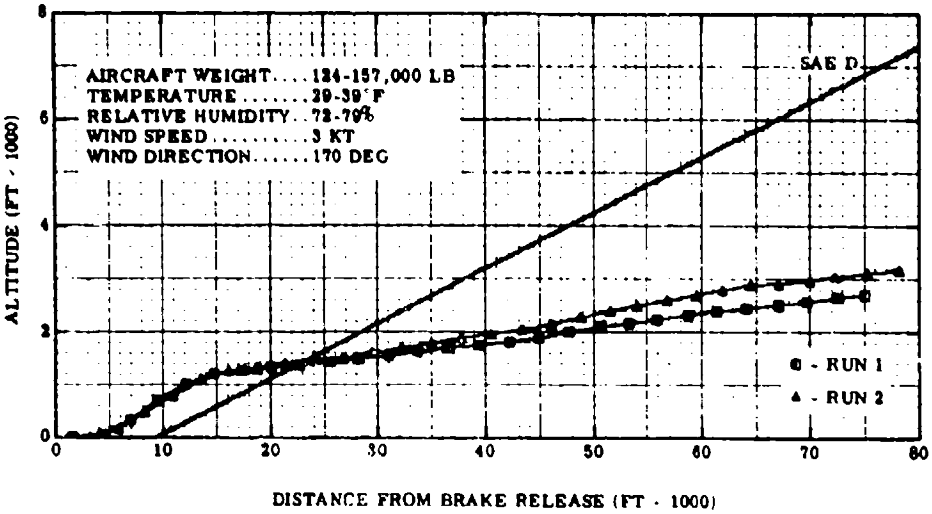

Figure A-23. Takeoff Profile T6, 727 Aircraft

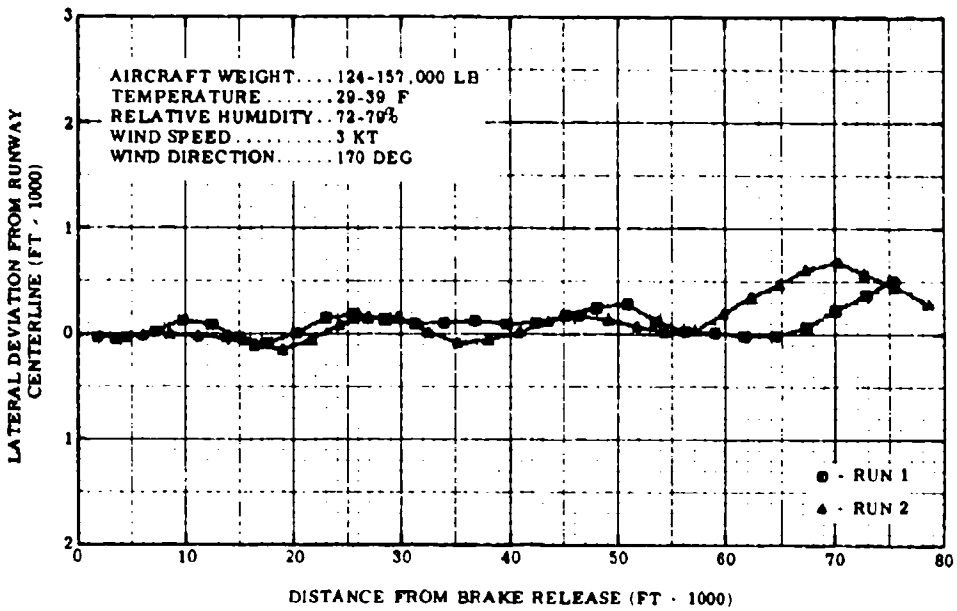

Figure A-24. Takeoff Lateral Deviation T6, 727 Aircraft

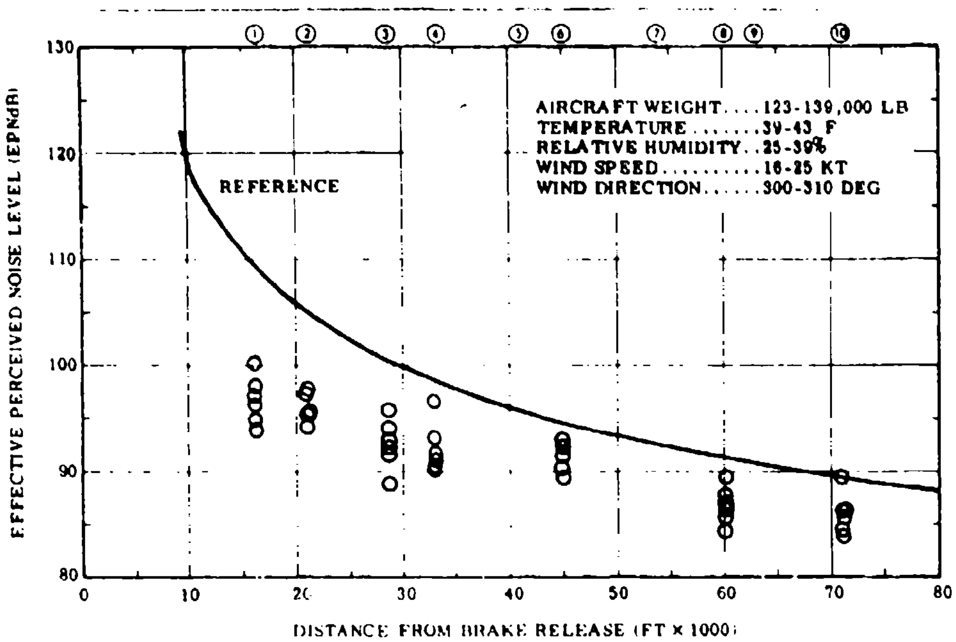

Figure A-25. Takeoff Noise Levels for Profile T7, 727 Aircraft

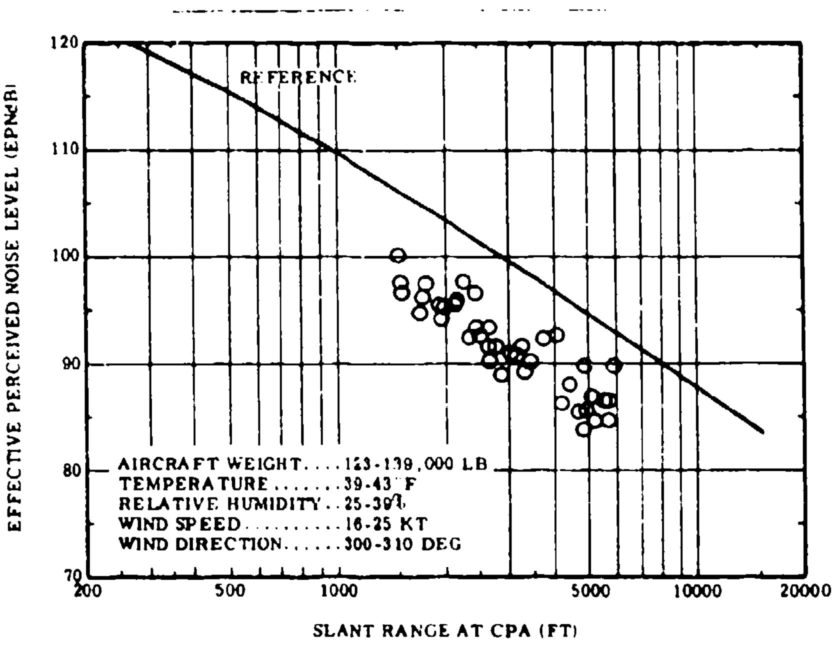

Figure A-26. Noise Levels as a Function of Slant Range for Profile T7, 727 Aircraft

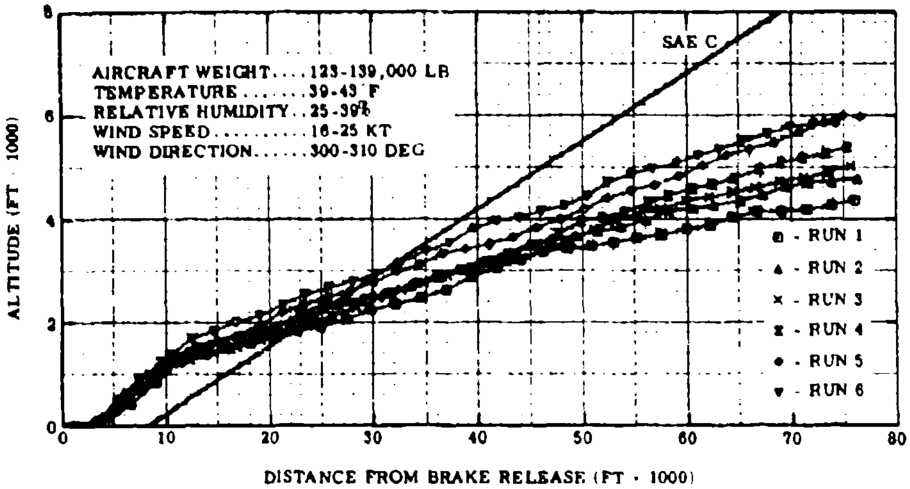

Figure A-27. Takeoff Profile T7, 727 Aircraft

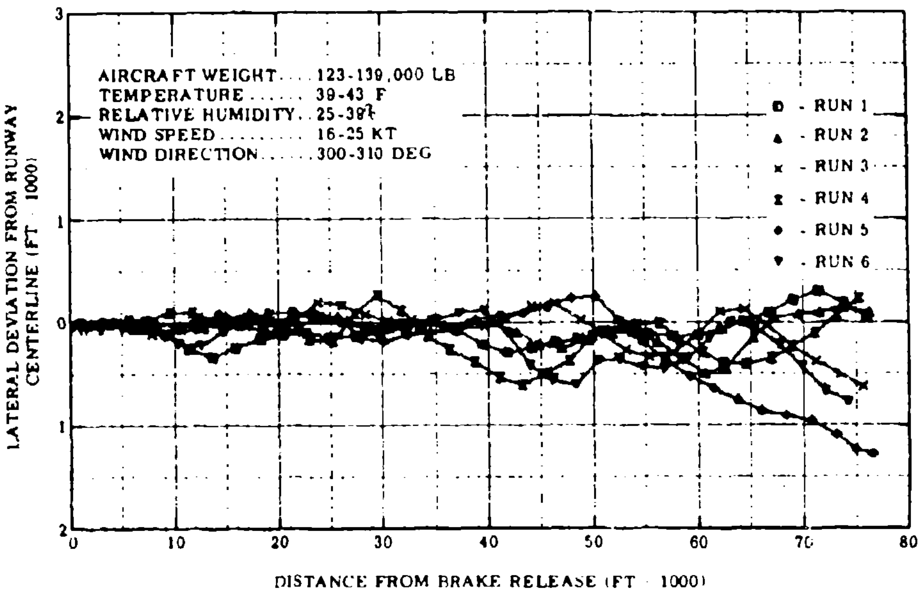

Figure A-28. Takeoff Lateral Deviation T7, 727 Aircraft

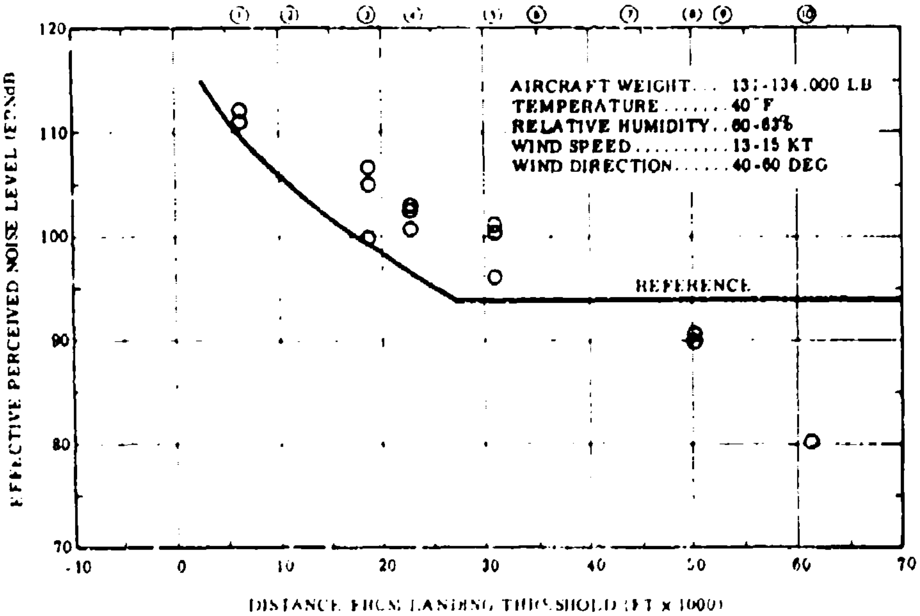

Figure A-29. Approach Noise Levels for Profile A11A, 727 Aircraft

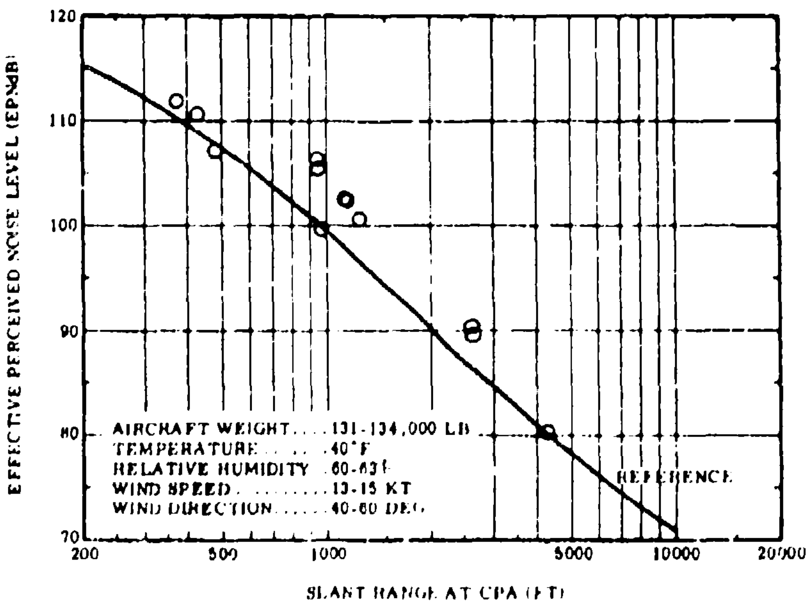

Figure A-30. Noise Levels as a Function of Slant Range for Profile A11A, 727 Aircraft

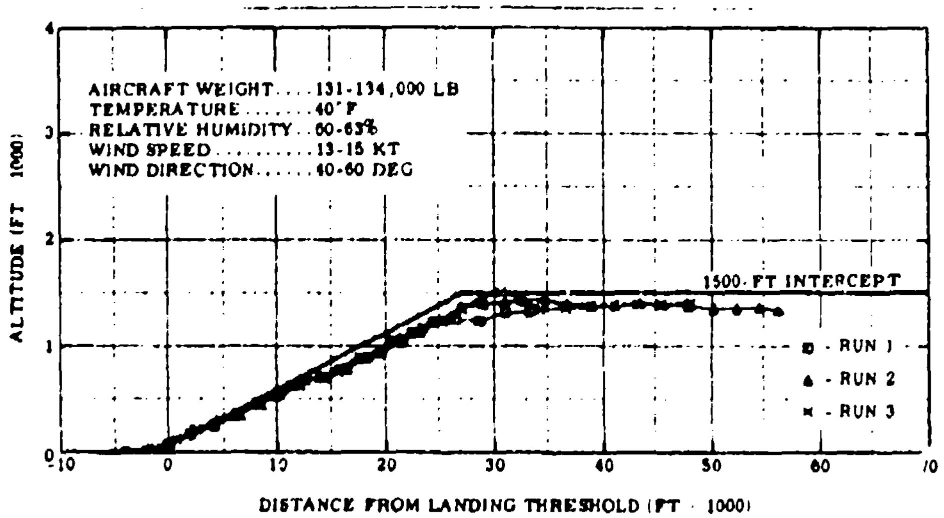

Figure A-31. Approach Profile A11A, 727 Aircraft

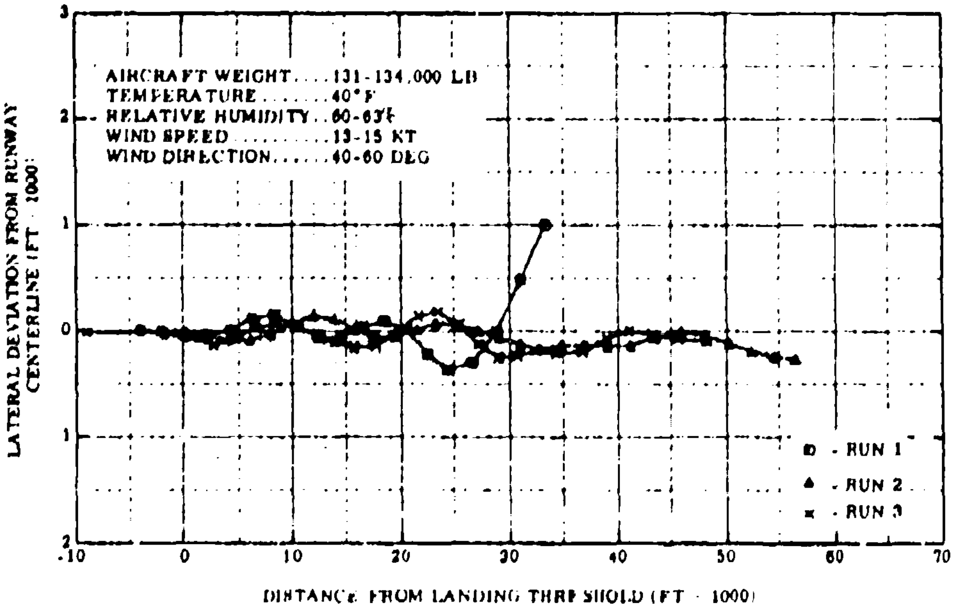

Figure A-32. Approach Lateral Deviation A11A, 727 Aircraft

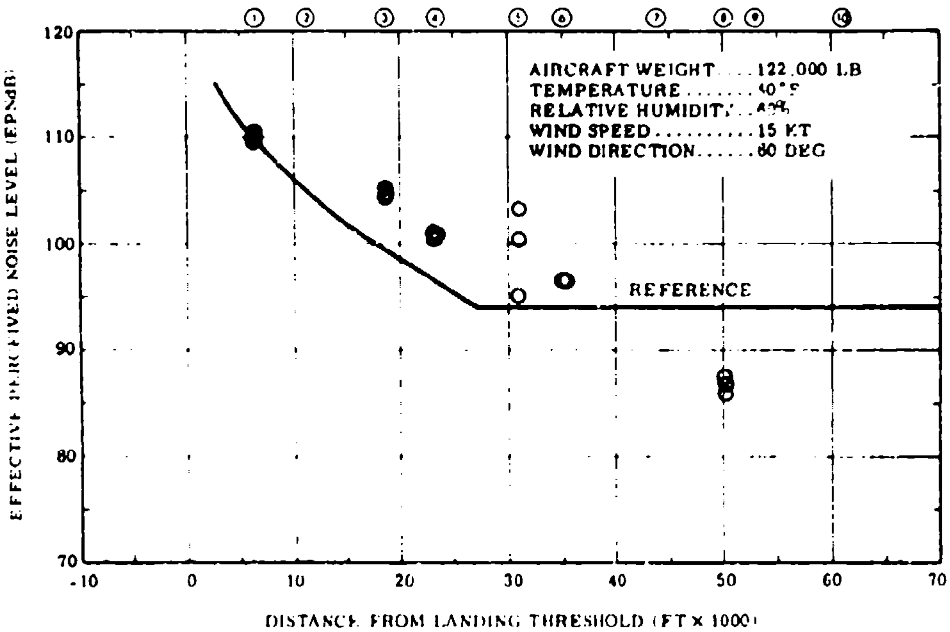

Figure A-33. Approach Noise Levels for Profile A11B, 727 Aircraft

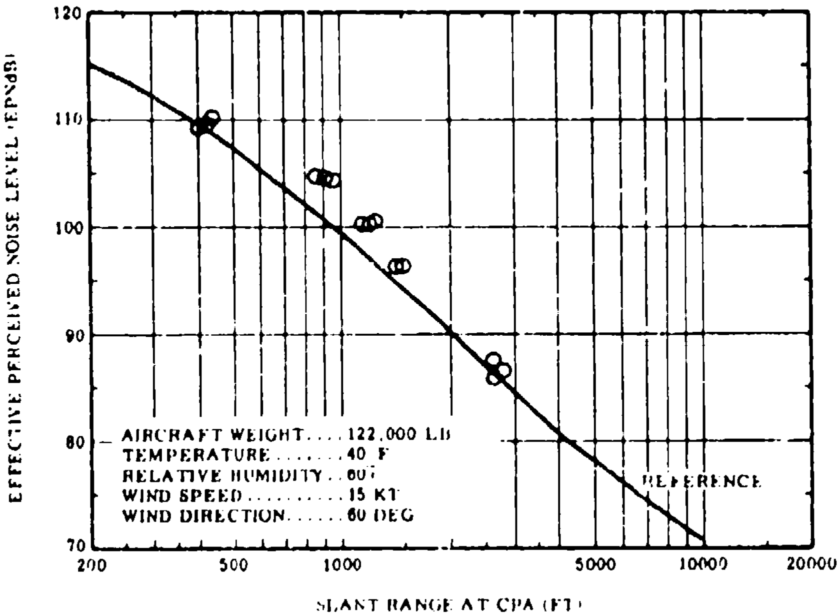

Figure A-34. Noise Levels as a Function of Slant Range for Profile A11B, 727 Aircraft

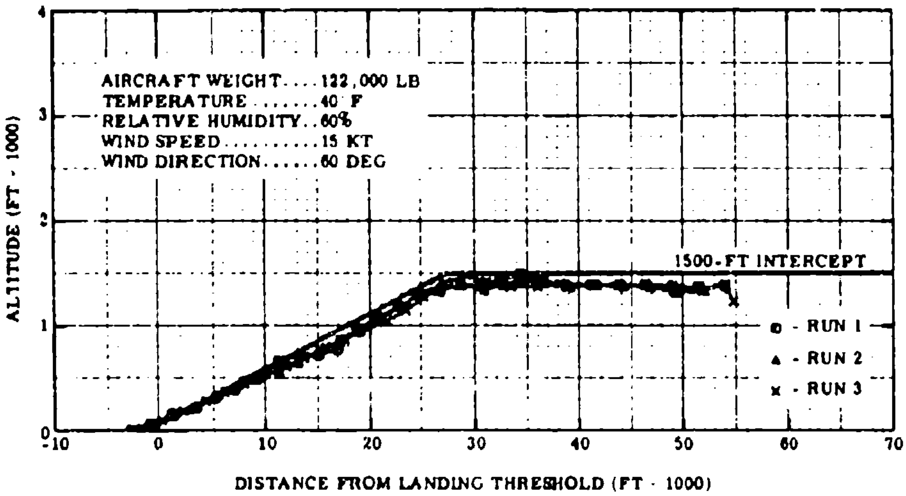

Figure A-35. Approach Profile A11B, 727 Aircraft

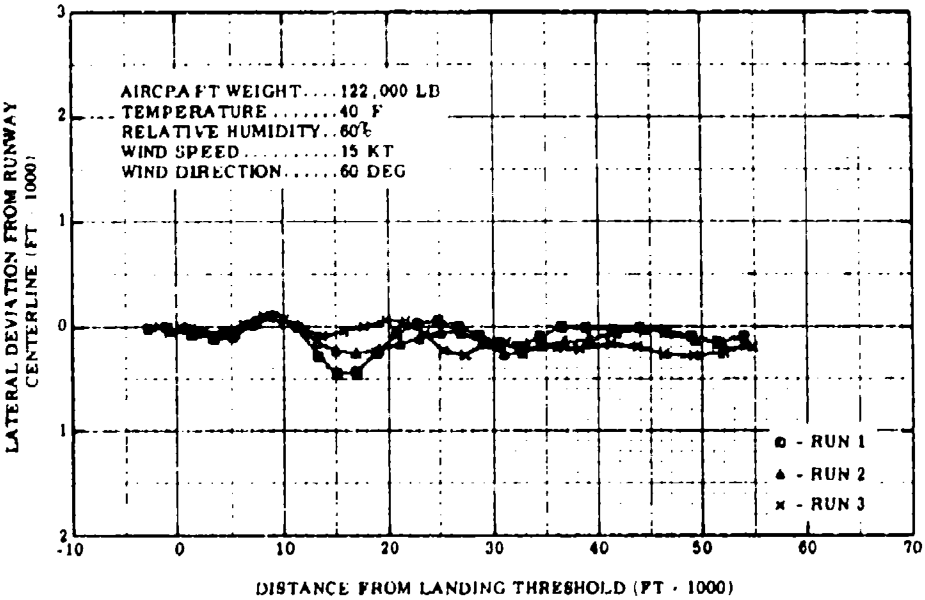

Figure A-36. Approach Lateral Deviation A11B, 727 Aircraft

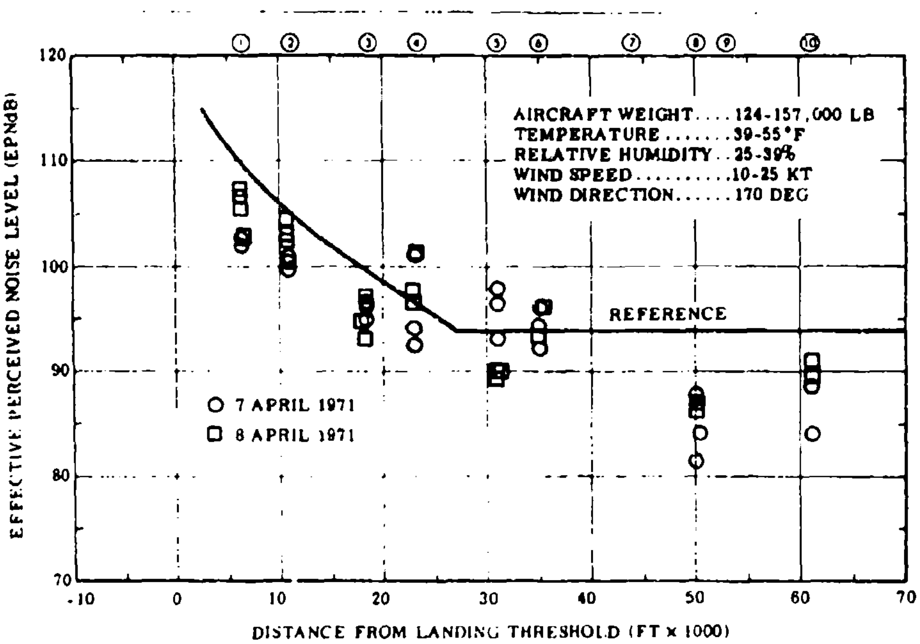

Figure A-37. Approach Noise Levels for Profile A12, 727 Aircraft

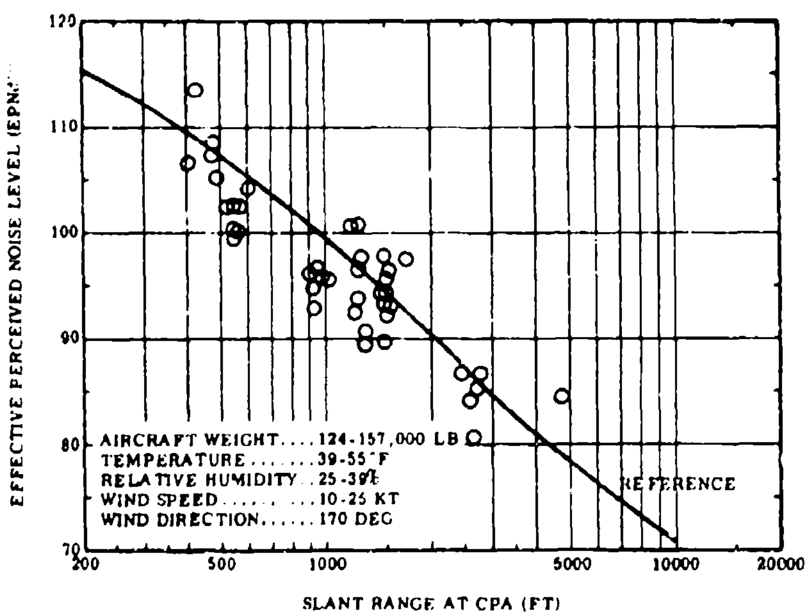

Figure A-38. Noise Levels as a Function of Slant Range for Profile A12, 727 Aircraft

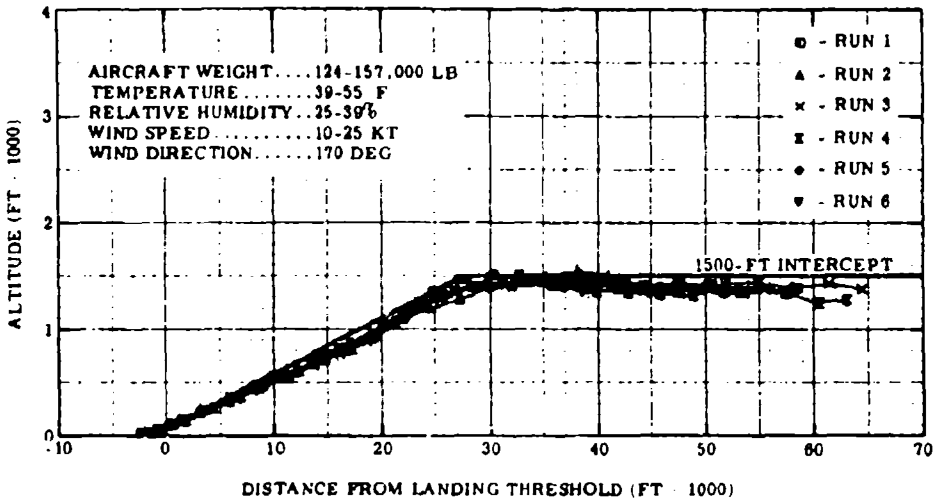

Figure A-39. Approach Profile A12, 727 Aircraft

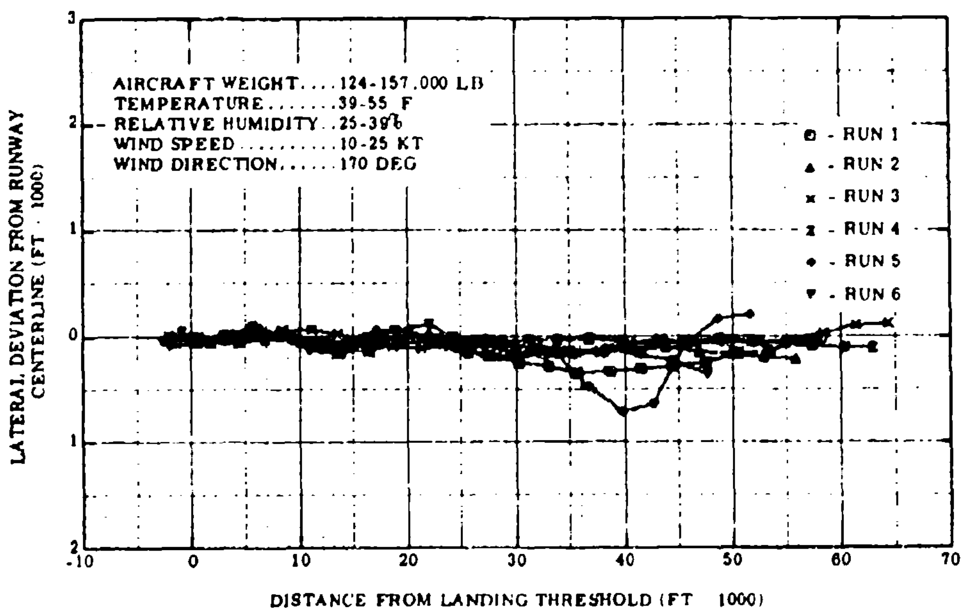

Figure A-40. Approach Lateral Deviation A12, 727 Aircraft

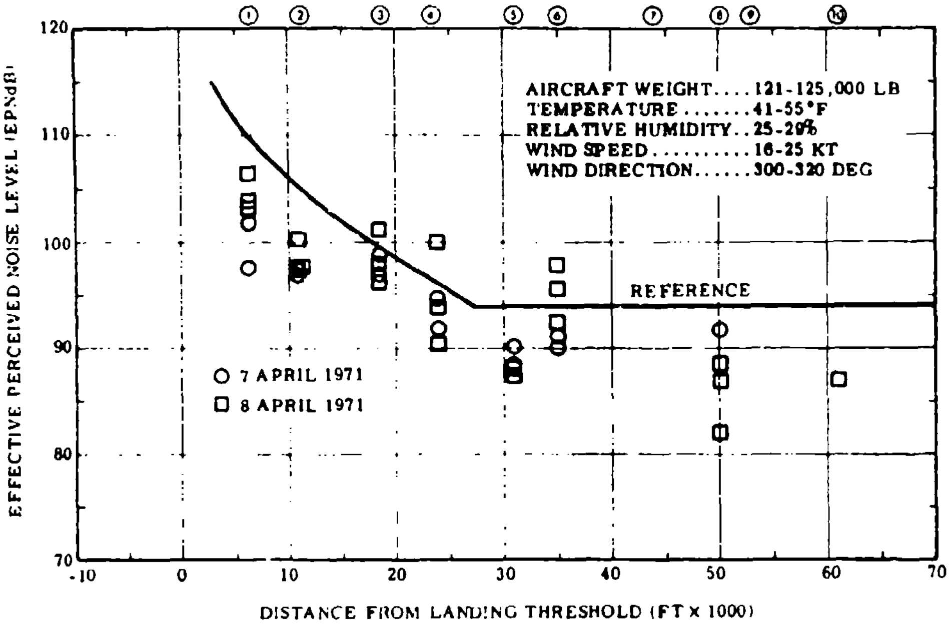

Figure A-41. Approach Noise Levels for Profile A13, 727 Aircraft

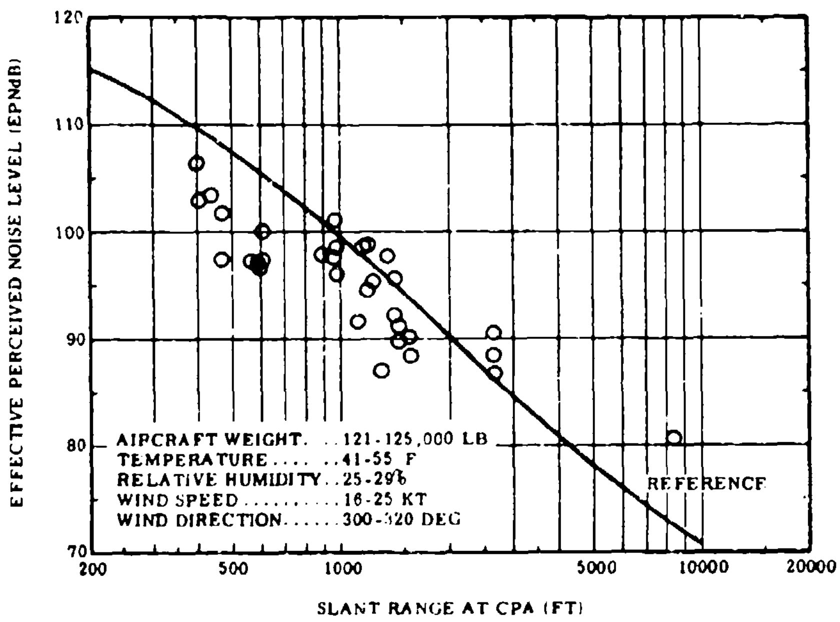

Figure A-42. Noise Levels as a Function of Slant Range for Profile A13, 727 Aircraft

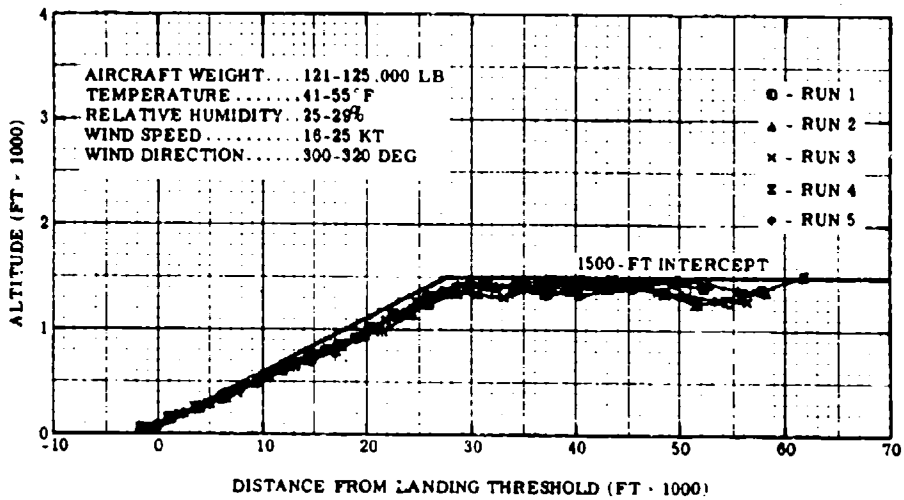

Figure A-43. Approach Profile A13, 727 Aircraft

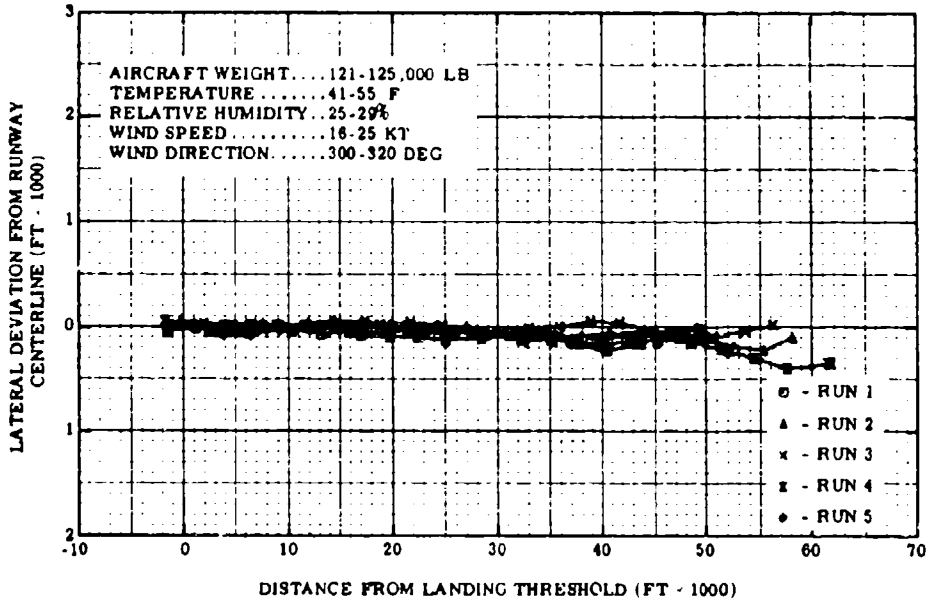

Figure A-44. Approach Lateral Deviation A13, 727 Aircraft

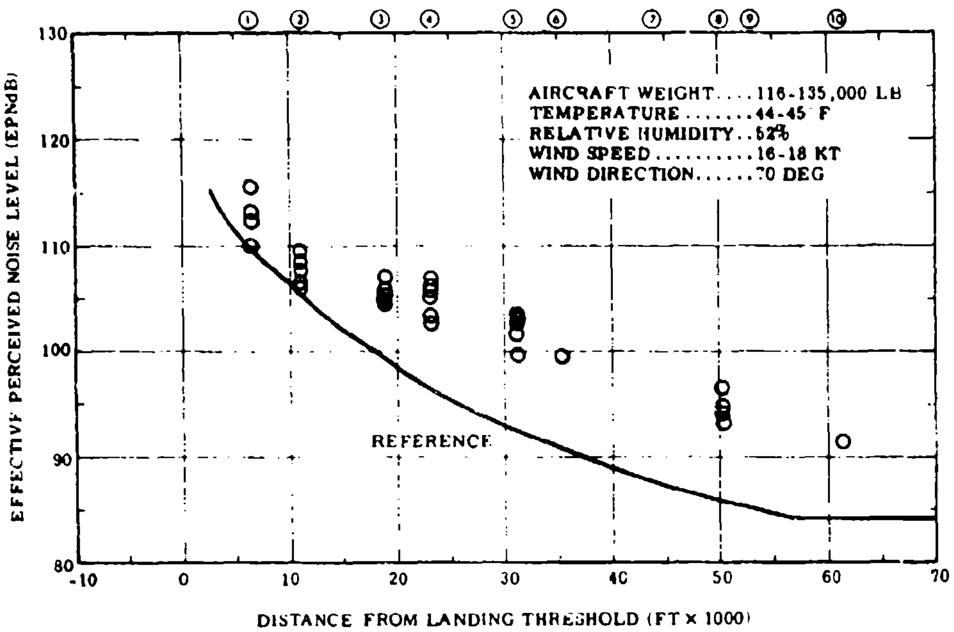

Figure A-45. Approach Noise Levels for Profile A21, 727 Aircraft

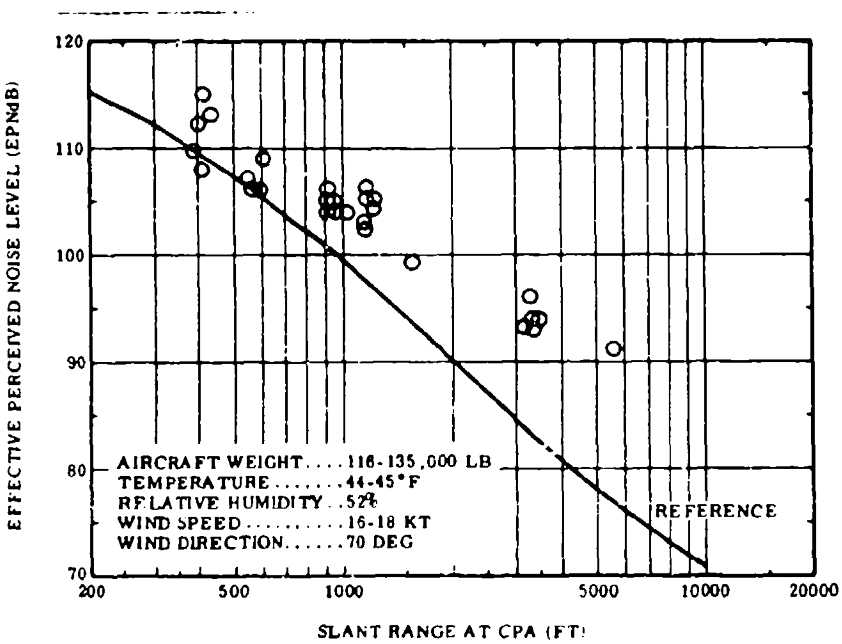

Figure A-46. Noise Levels as a Function of Slant Range for Profile A21, 727 Aircraft

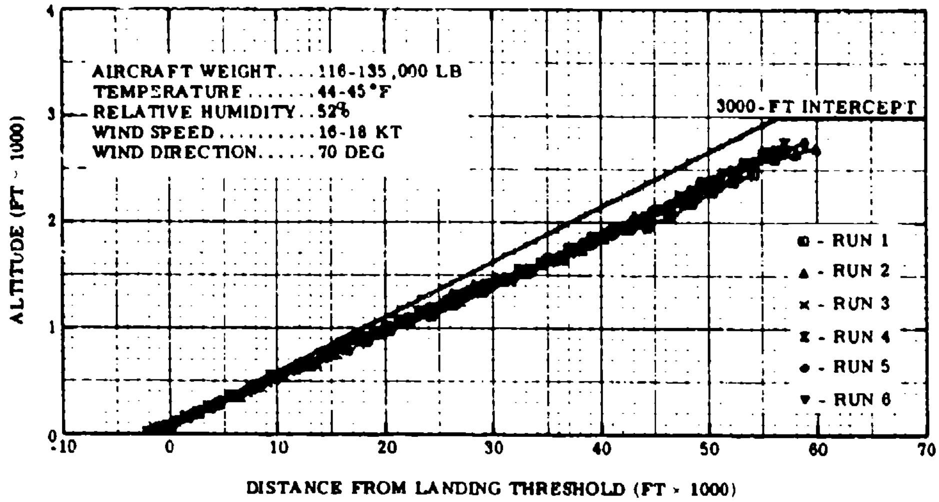

Figure A-47. Approach Profile A21, 727 Aircraft

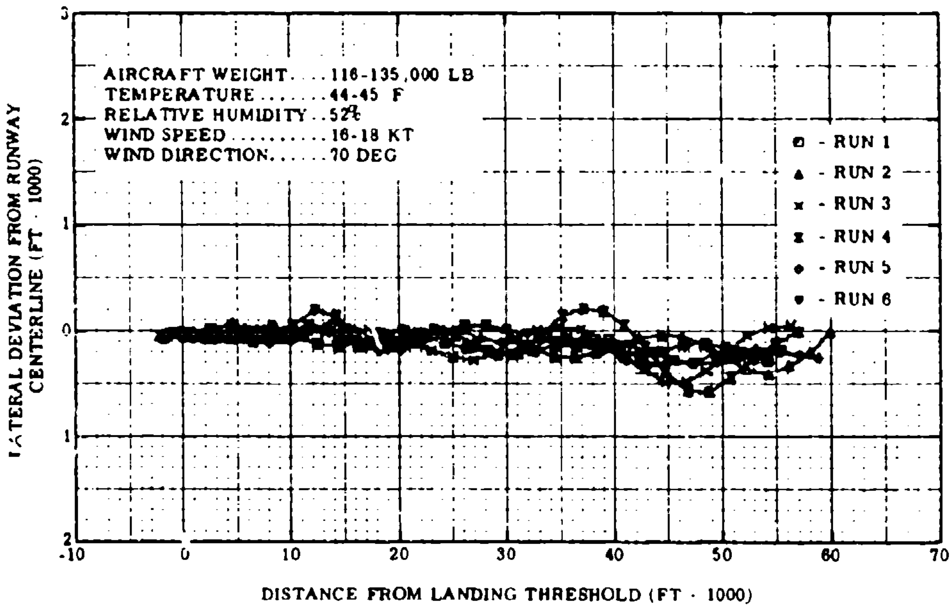

Figure A-48. Approach Lateral Deviation A21, 727 Aircraft

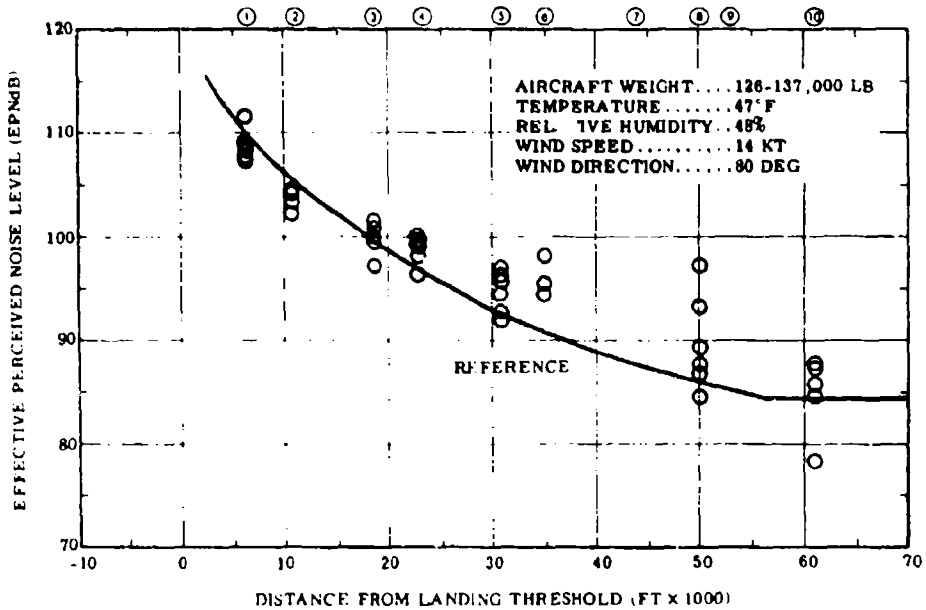

Figure A-49. Approach Noise Levels for Profile A31, 727 Aircraft

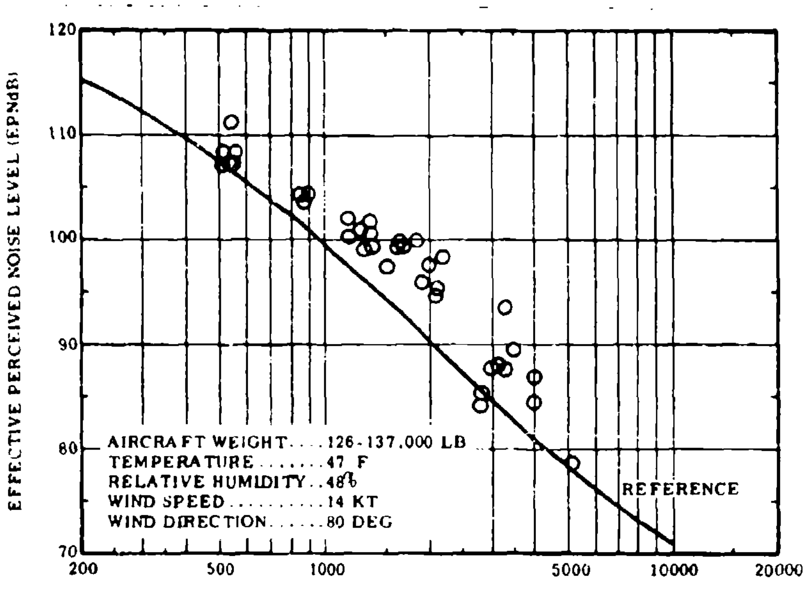

Figure A-50. Noise Levels as a Function of Slant Range for Profile A31, 727 Aircraft

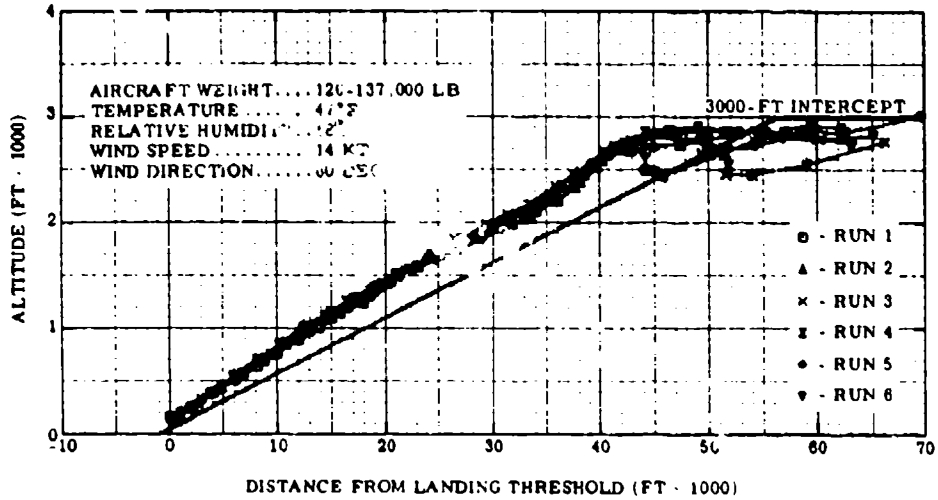

Figure A-51. Approach Profile A31, 727 Aircraft

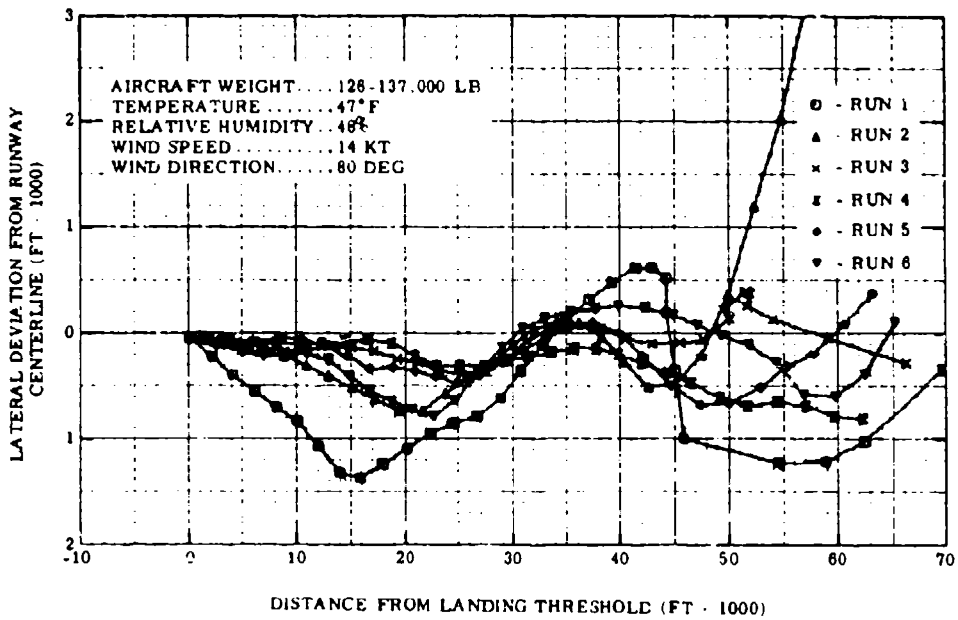

Figure A-52. Approach Lateral Deviation A31, 727 Aircraft

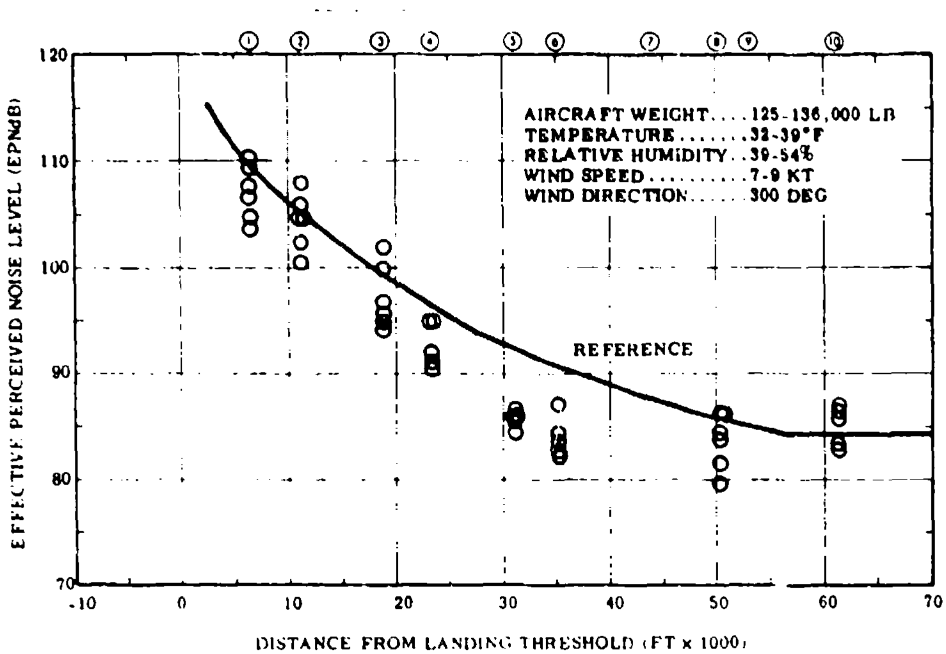

Figure A-53. Approach Noise Levels for Profile A41, 727 Aircraft

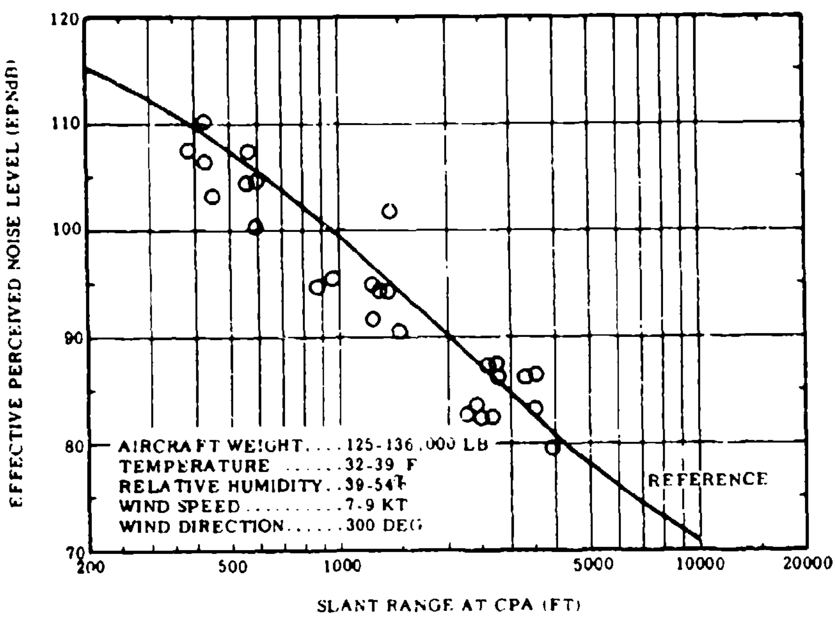

Figure A-54. Noise Levels as a Function of Slant Range for Profile A41, 727 Aircraft

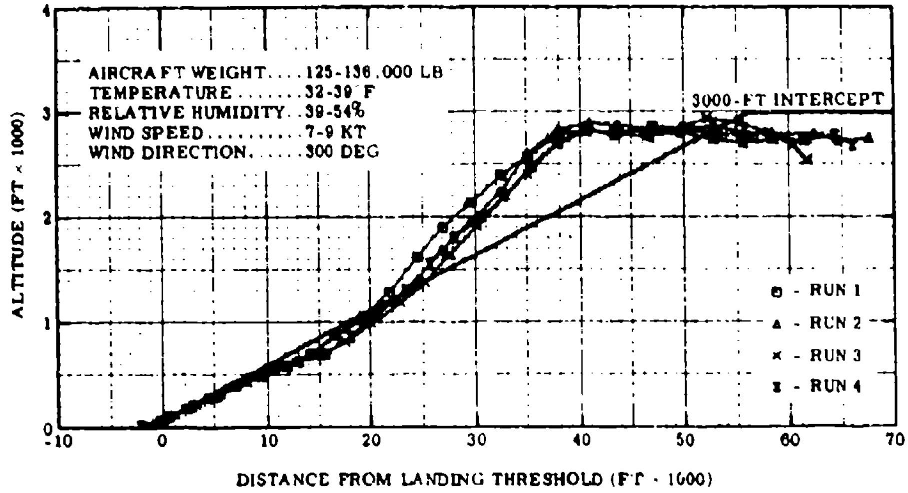

Figure A-55. Approach Profile A41, 727 Aircraft

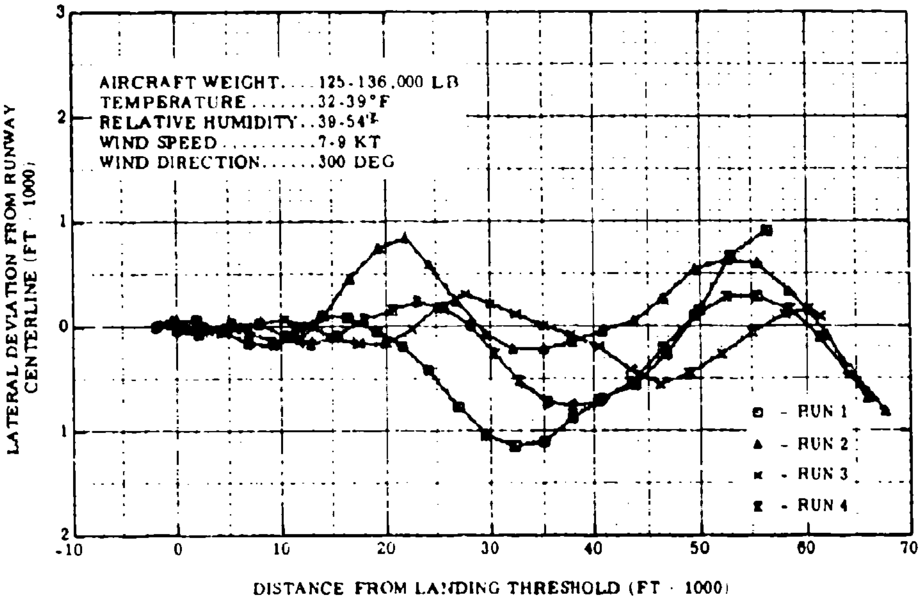

Figure A-56. Approach Lateral Deviation A41, 727 Aircraft

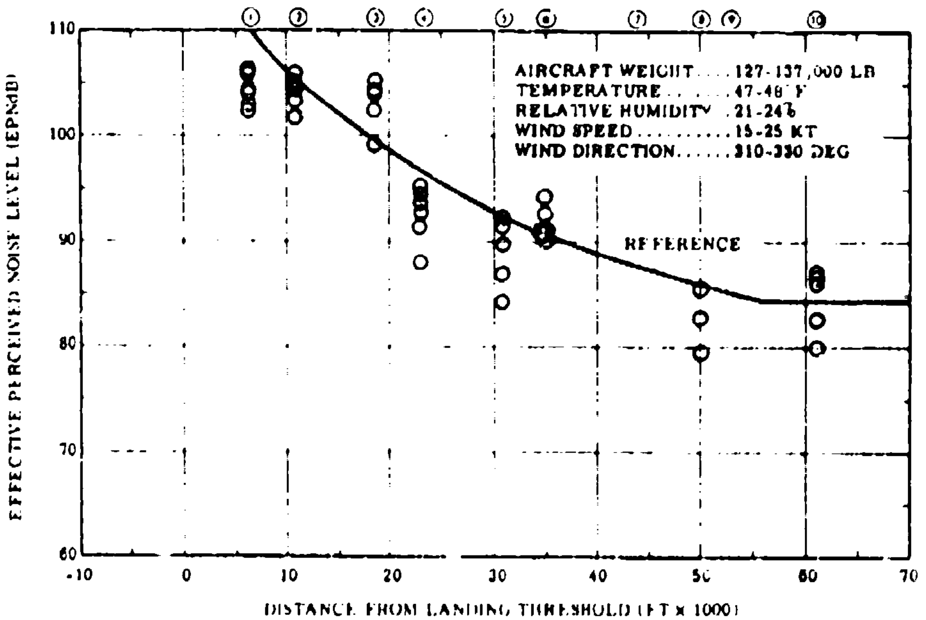

Figure A-57. Approach Noise Levels for Profile A51, 727 Aircraft

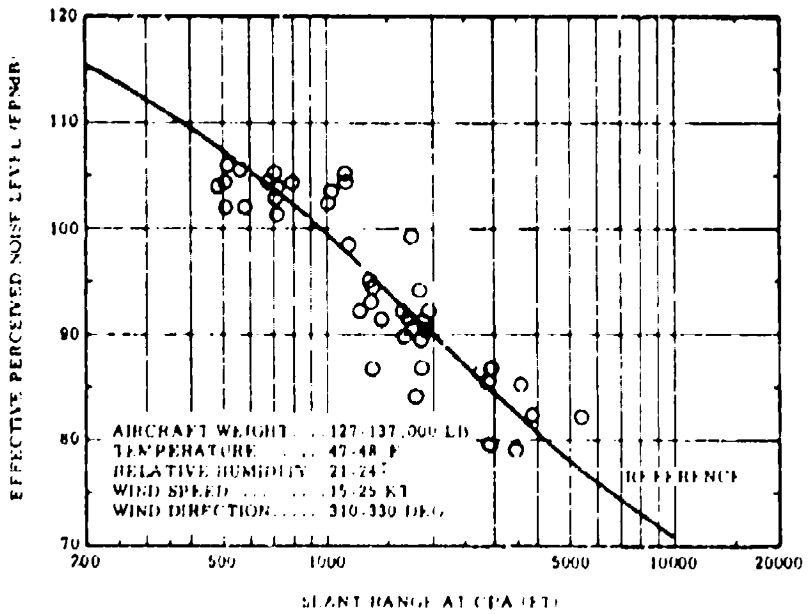

Figure A-58. Noise Levels as a Function of Slant Range for Profile A51, 727 Aircraft

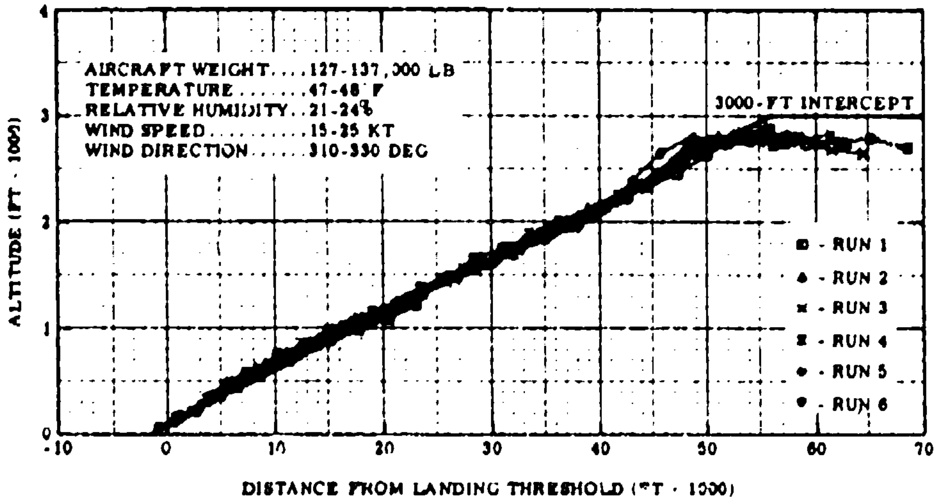

Figure A-59. Approach Profile A51, 727 Aircraft

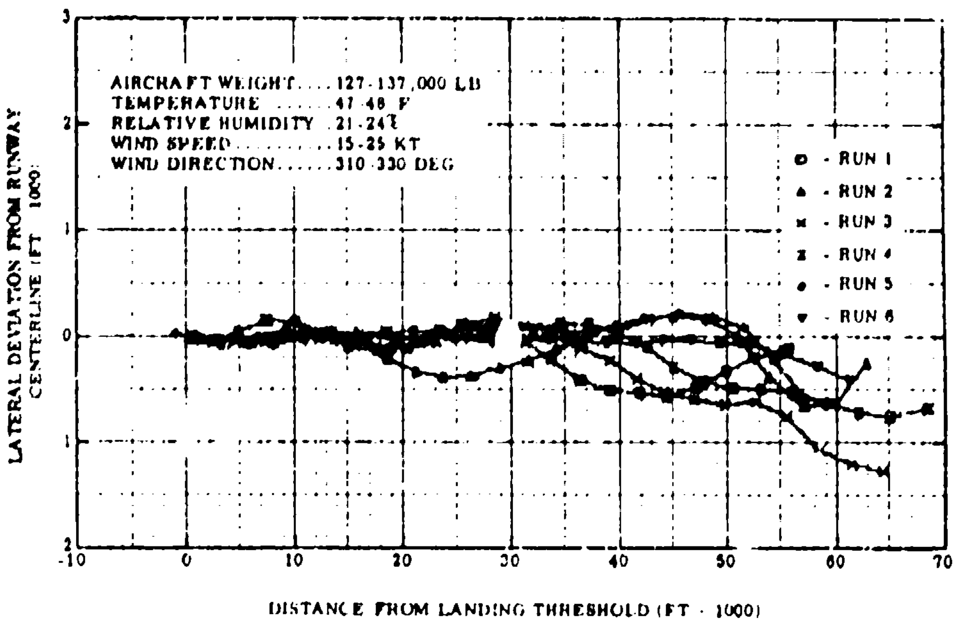

Figure A-60. Approach Lateral Deviation A51, 727 Aircraft

Appendix B

KC-135 AIRCRAFT
DETAILED NOISE AND TRACKING PLOTS

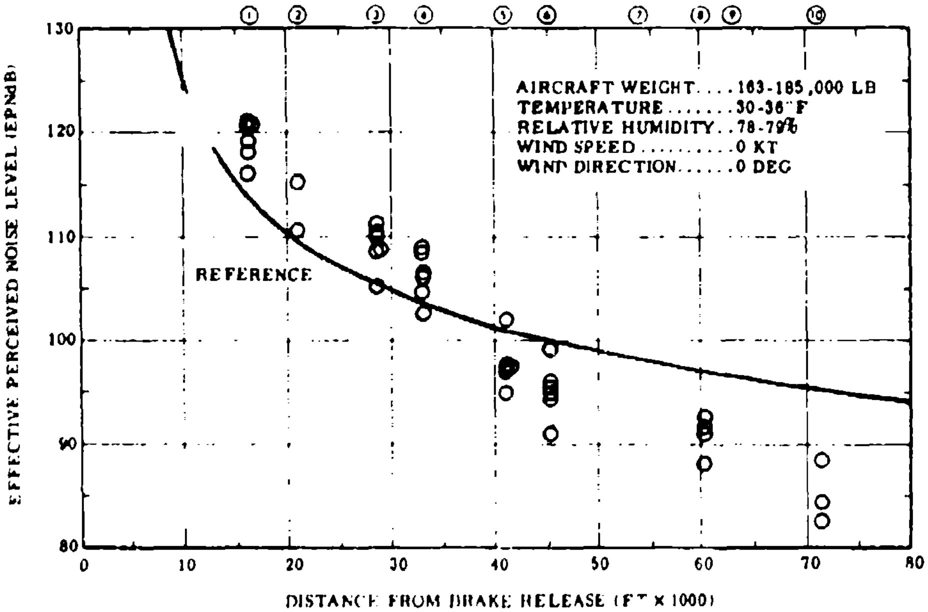

Figure B-1. Takeoff Noise Levels for Profile T1, KC-135 Aircraft

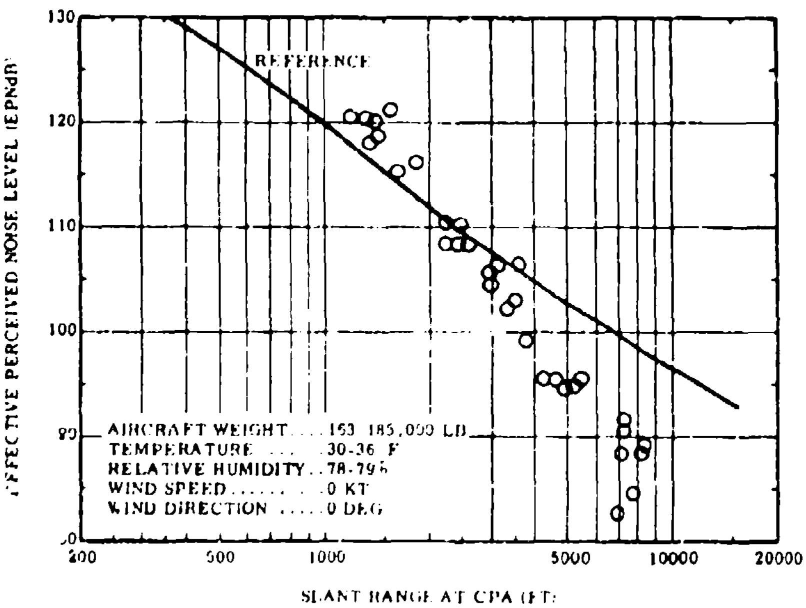

Figure B-2. Noise Levels as a Function of Slant Range for Profile T1, KC-135 Aircraft

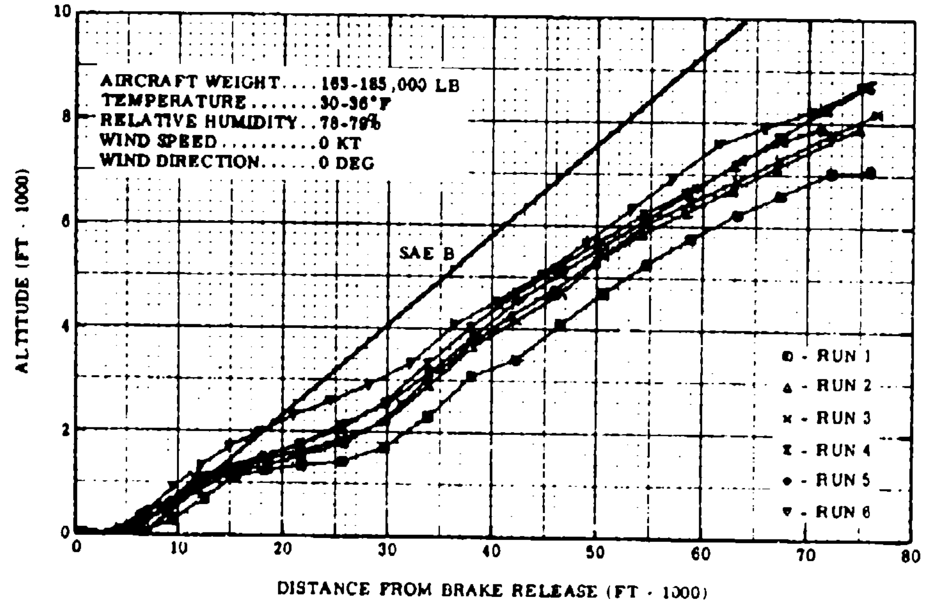

Figure B-3. Takeoff Profile T1, KC-135 Aircraft

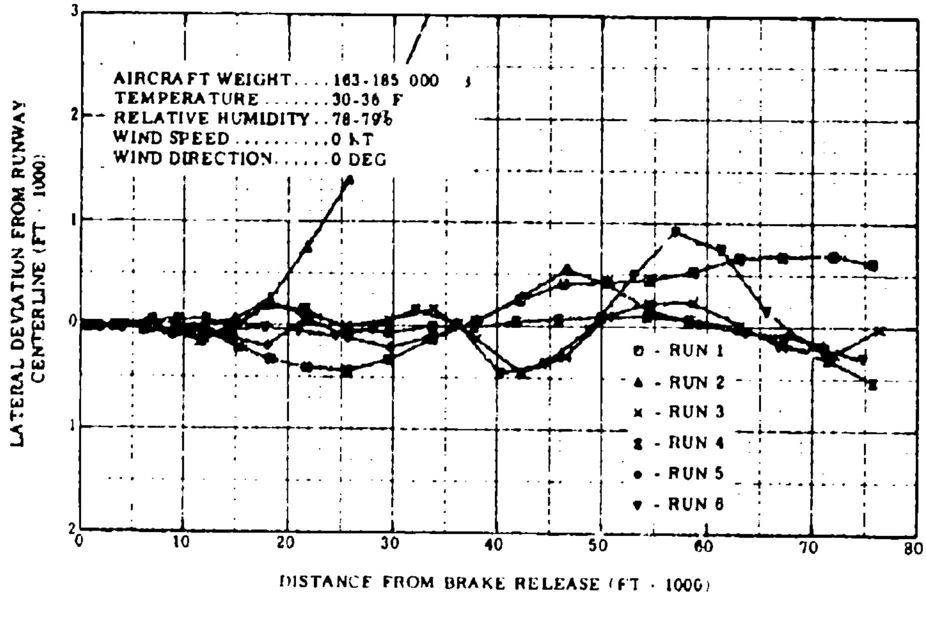

Figure B-4. Takeoff Lateral Deviation T1, KC-135 Aircraft

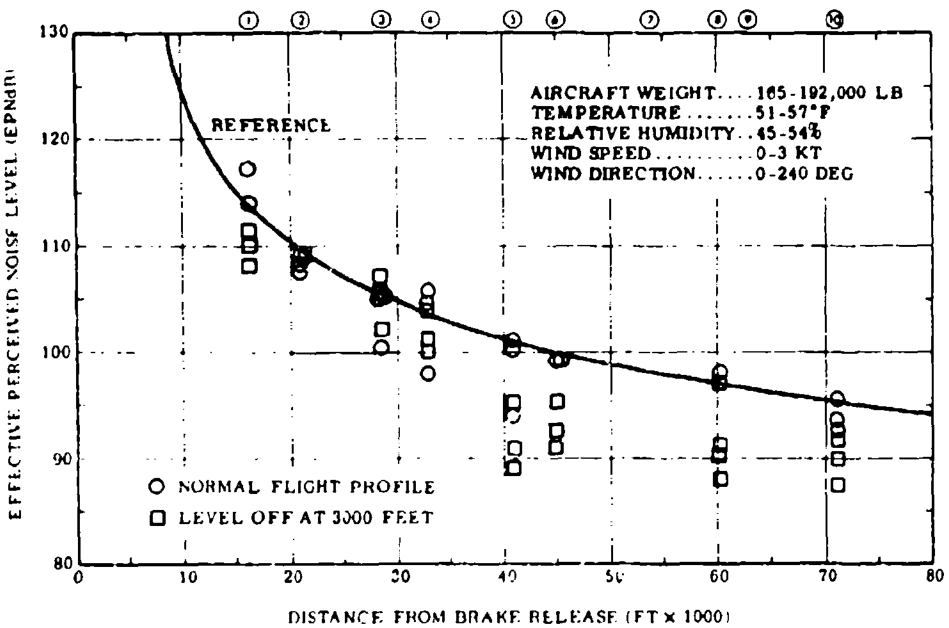

Figure B-5. Takeoff Noise Levels for Profile T2, KC-135 Aircraft

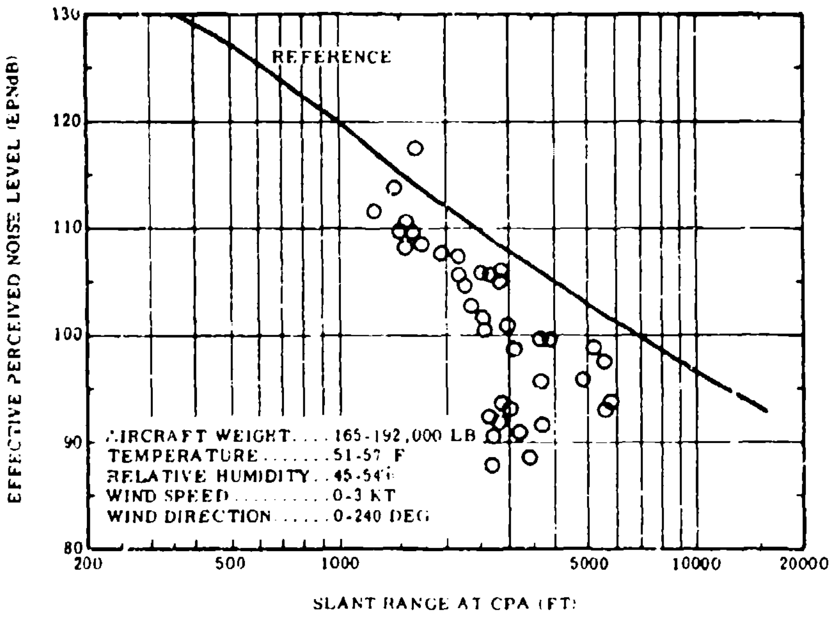

Figure B-6. Noise Levels as a Function of Slant Range for Profile T2, KC-135 Aircraft

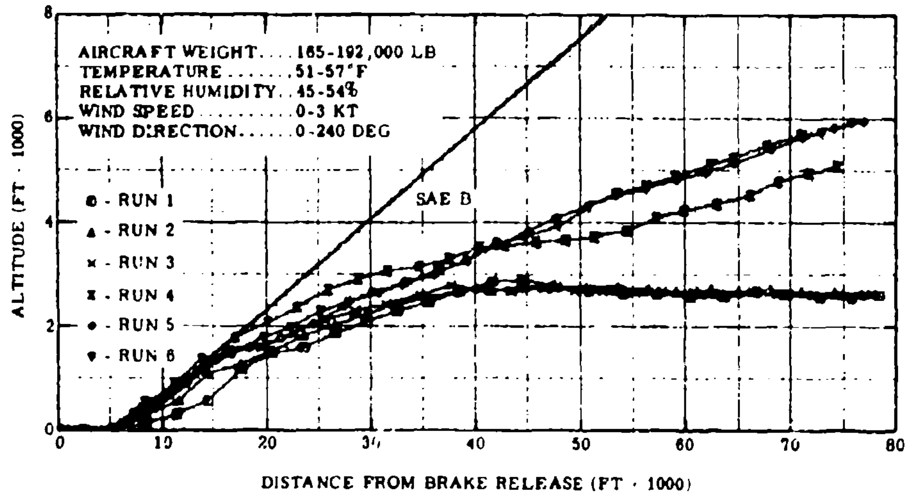

Figure B-7. Takeoff Profile T2, KC-135 Aircraft

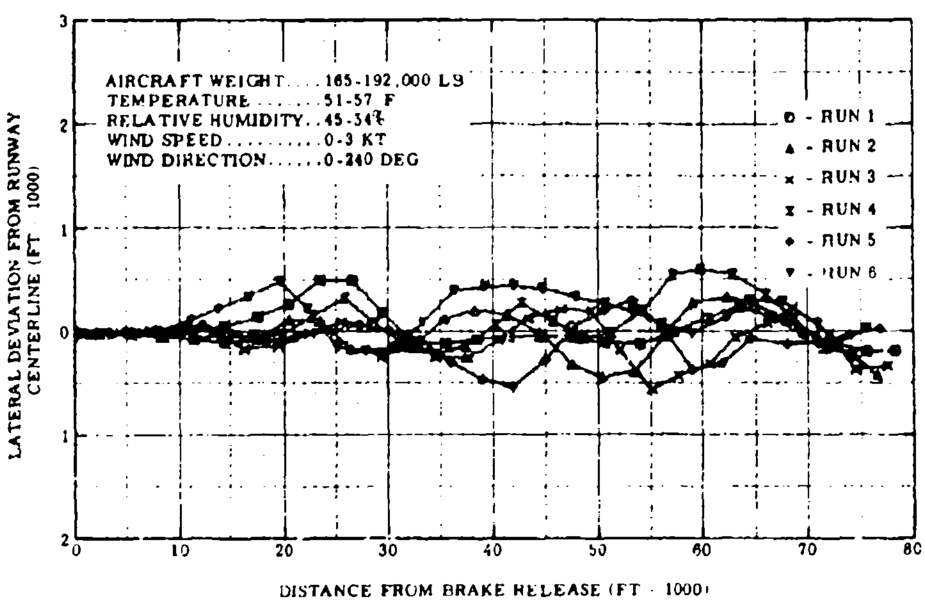

Figure B-8. Takeoff Lateral Deviation T2, KC-135 Aircraft

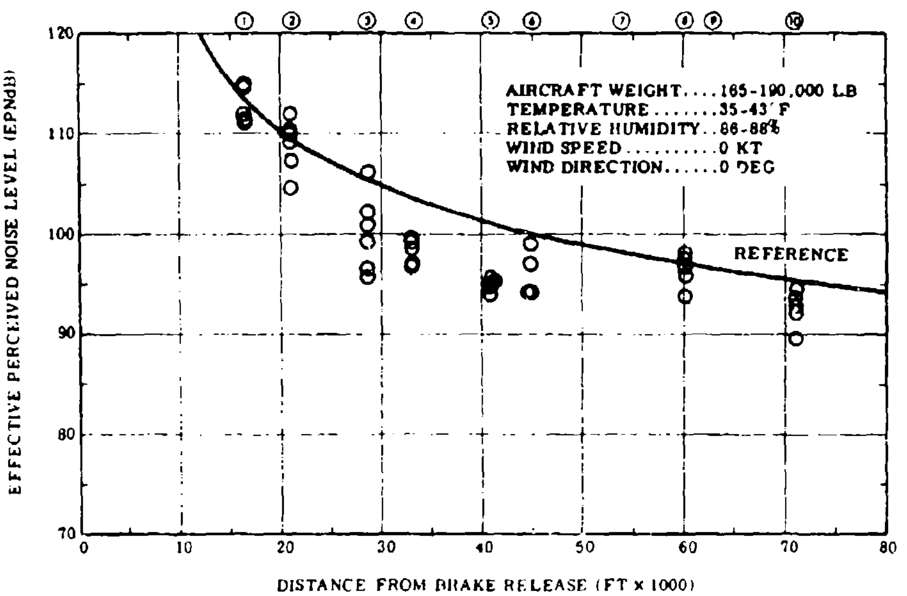

Figure B-9. Takeoff Noise Levels for Profile T3, KC-135 Aircraft

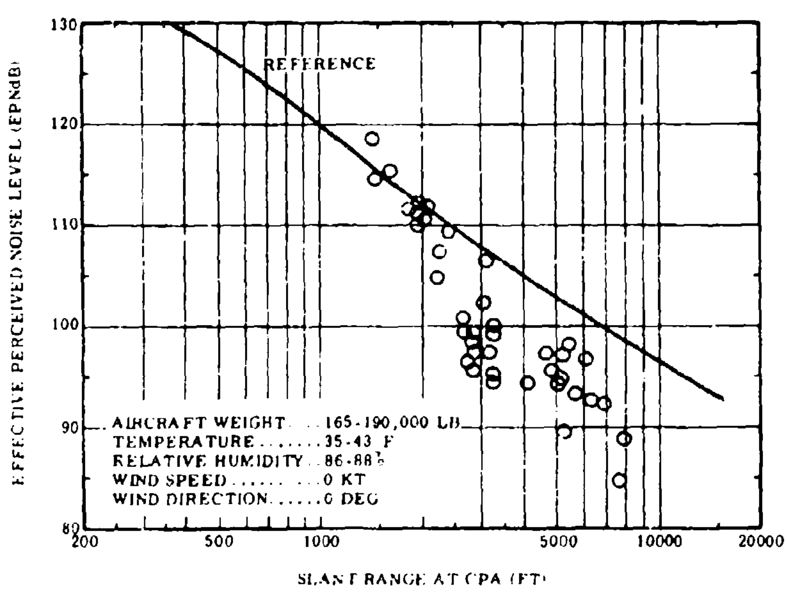

Figure B-10. Noise Levels as a Function of Slant Range for Profile T3, KC-135 Aircraft

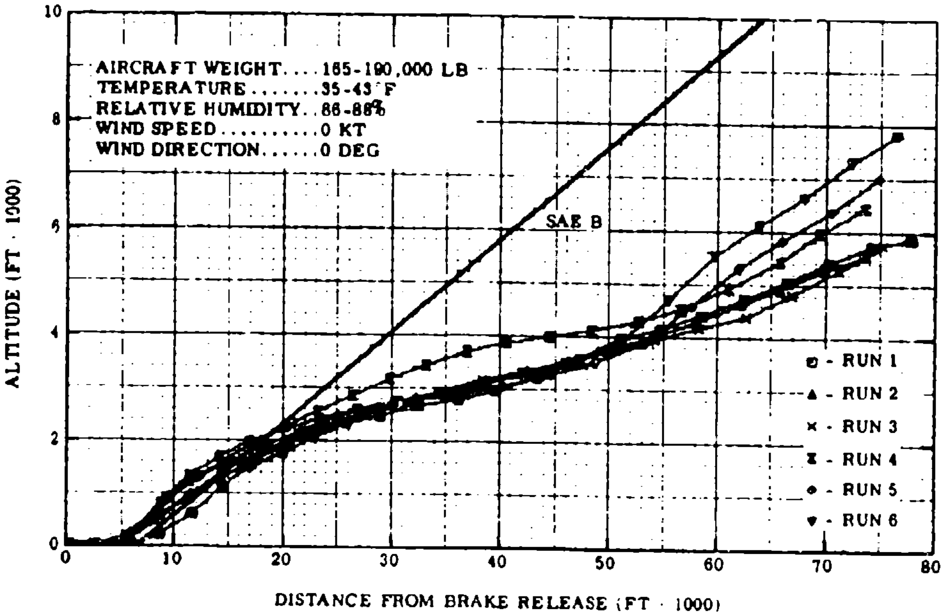

Figure B-11. Takeoff Profile T3, KC-135 Aircraft

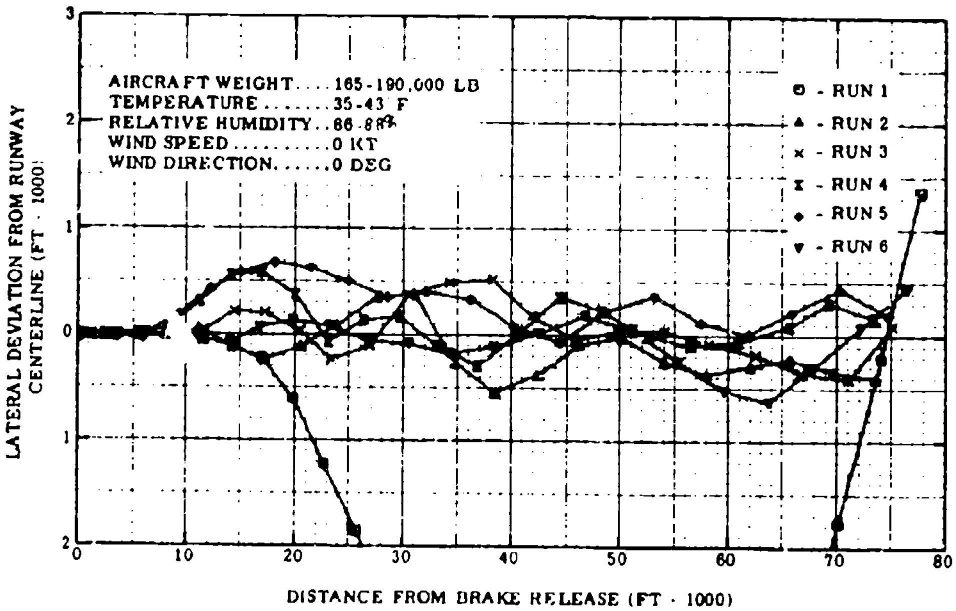

Figure B-12. Takeoff Lateral Deviation T3, KC-135 Aircraft

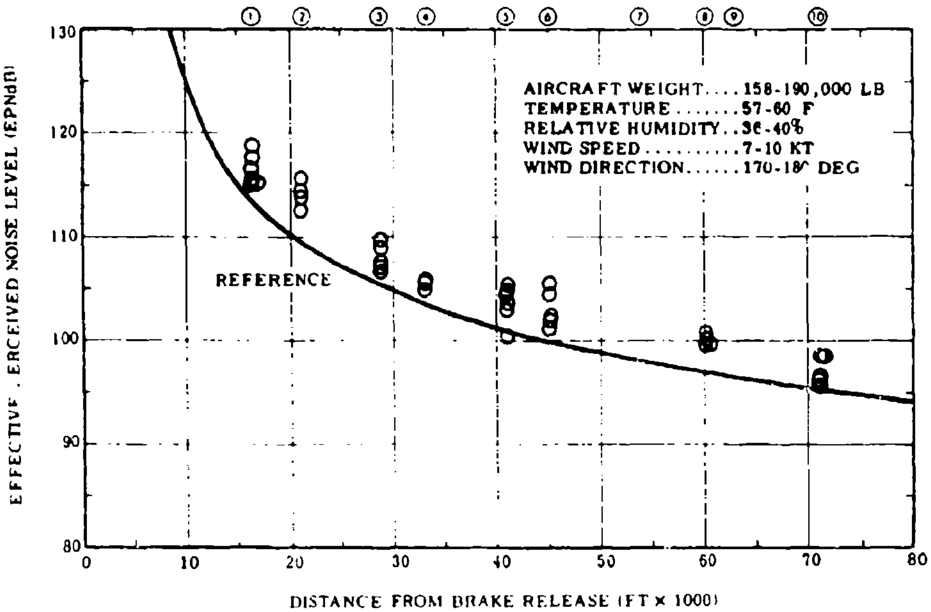

Figure B-13. Takeoff Noise Levels for Profile T4, KC-135 Aircraft

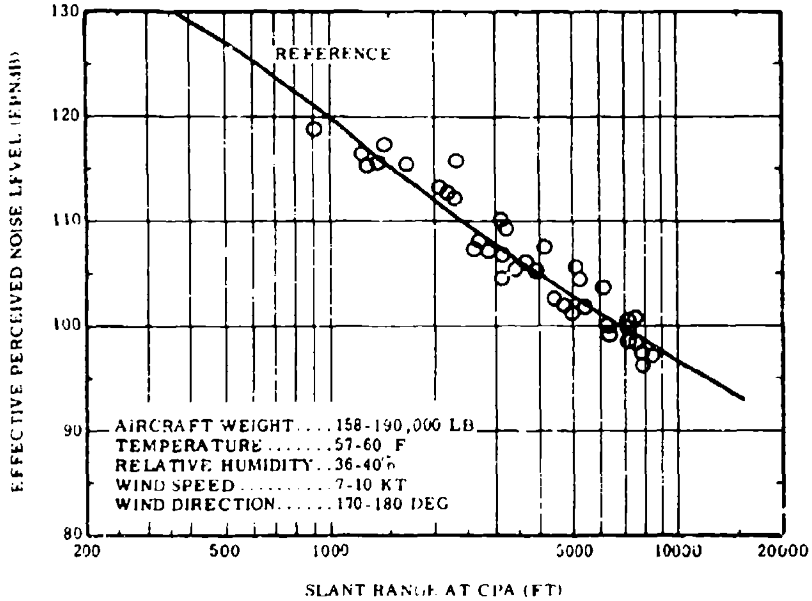

Figure B-14. Noise Levels as a Function of Slant Range for Profile T4, KC-135 Aircraft

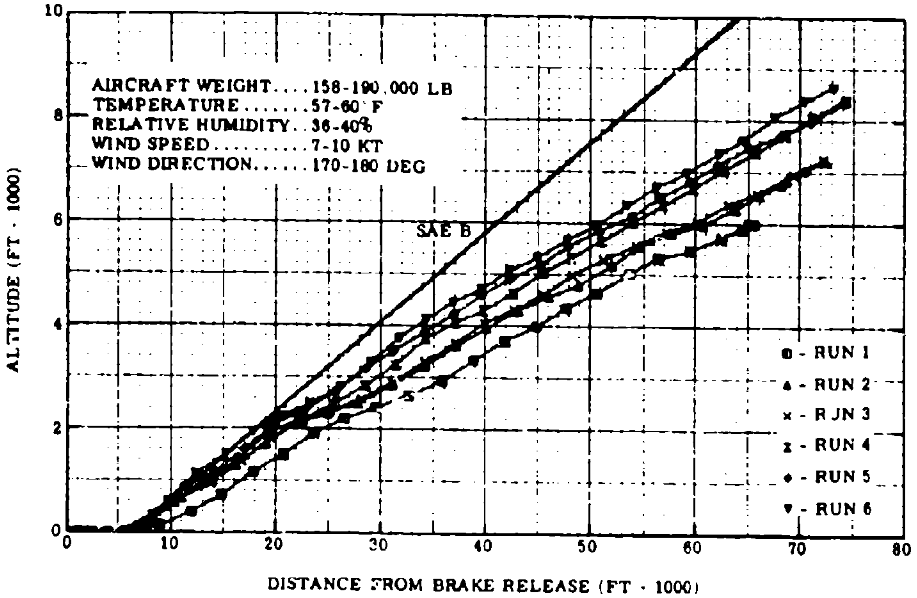

Figure B-15. Takeoff Profile T4, KC-135 Aircraft

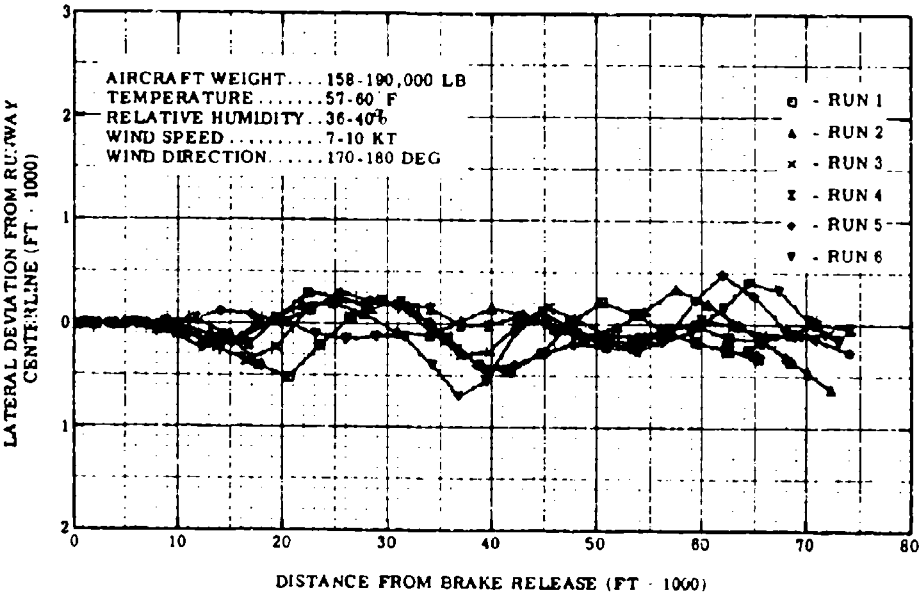

Figure B-16. Takeoff Lateral Deviation T4, KC-135 Aircraft

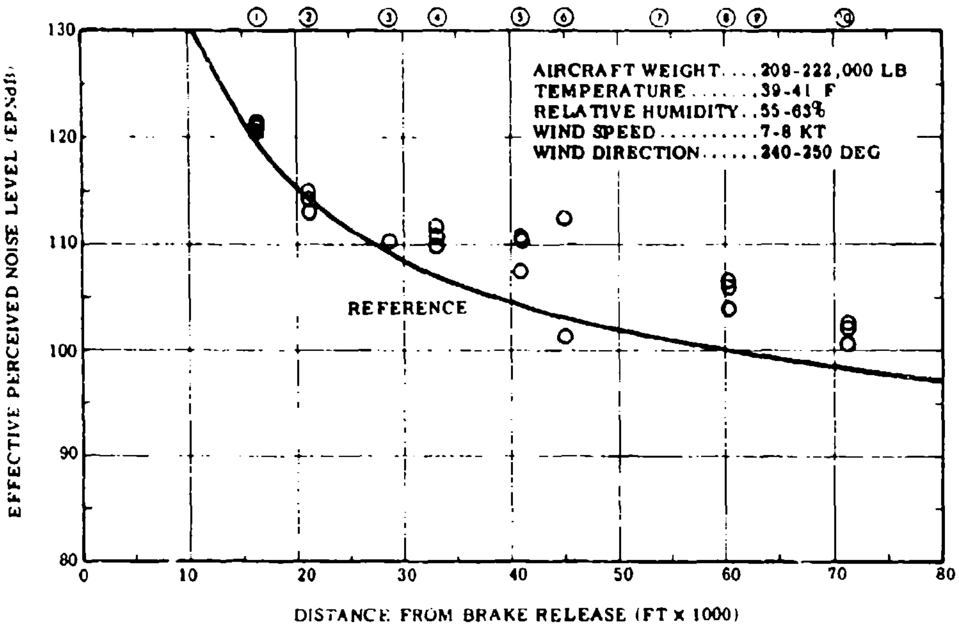

Figure B-17. Takeoff Noise Levels for Profile T5, KC-135 Aircraft

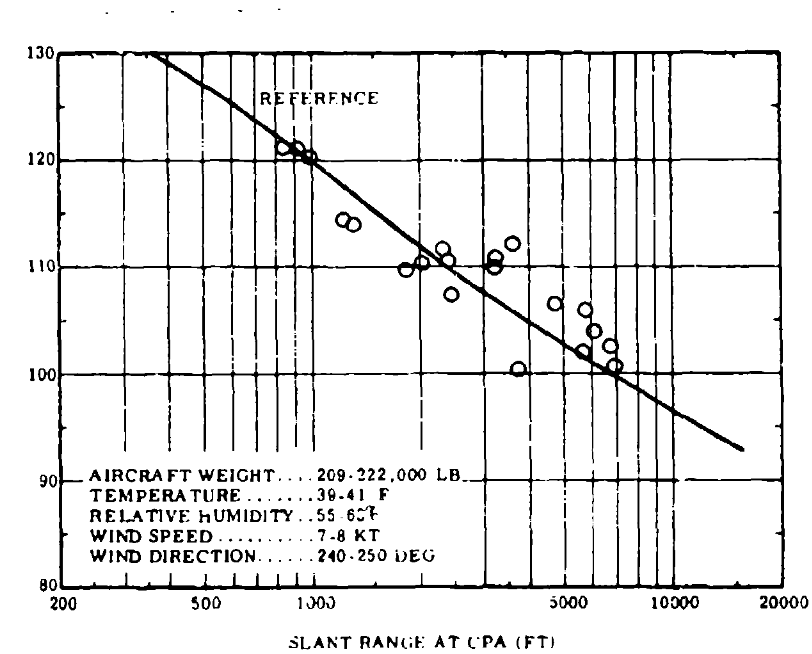

Figure B-18. Noise Levels as a Function of Slant Range for Profile T5, KC-135 Aircraft

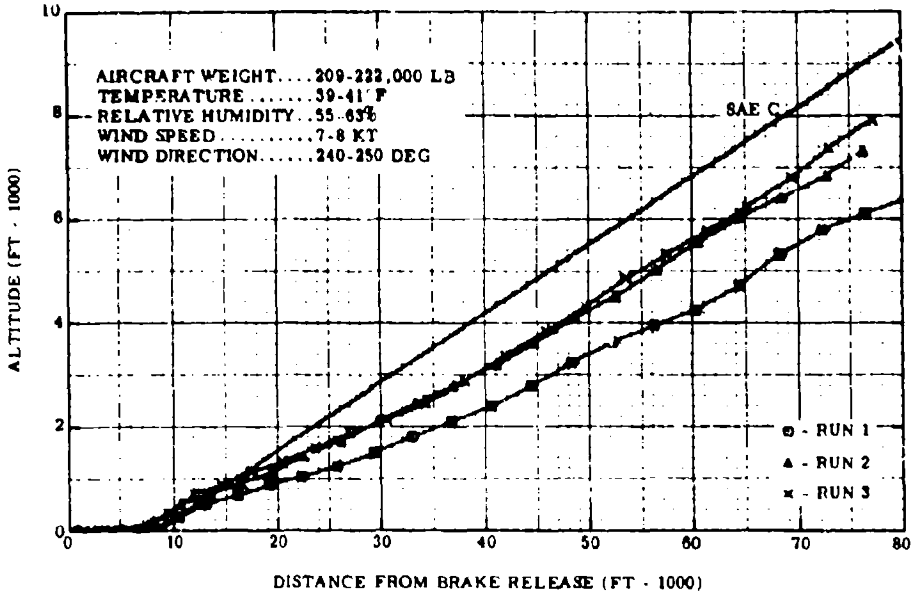

Figure B-19. Takeoff Profile T5, KC-135 Aircraft

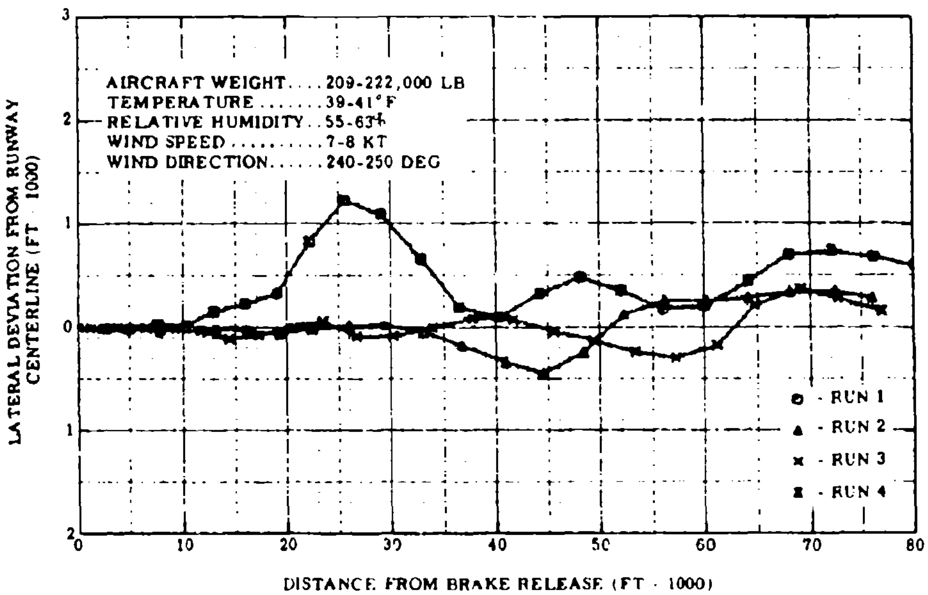

Figure B-20. Takeoff Lateral Deviation T5, KC-135 Aircraft

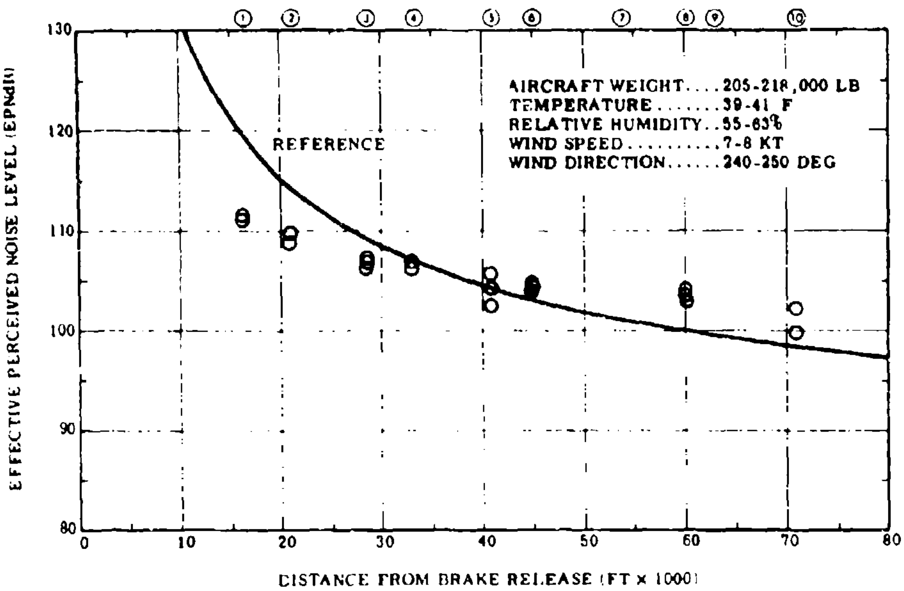

Figure B-21. Takeoff Noise Levels for Profile T6, KC-135 Aircraft

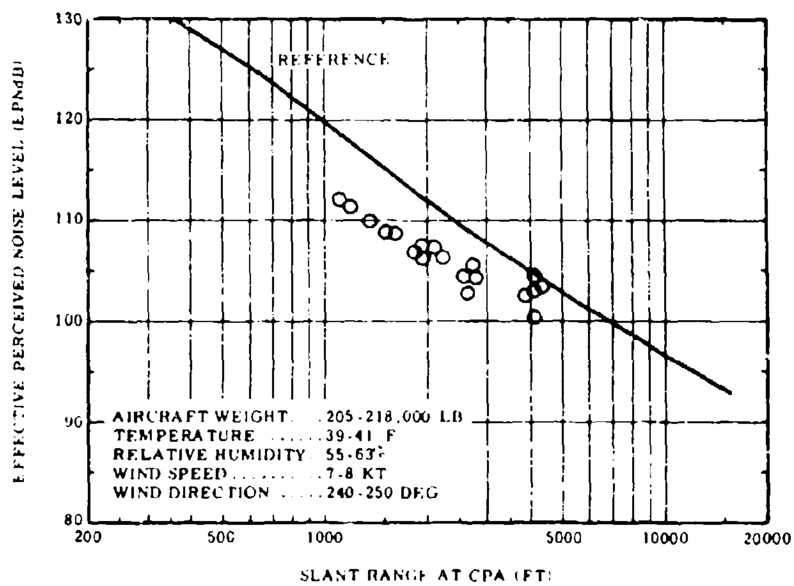

Figure B-22. Noise Levels as a Function of Slant Range for Profile T6, KC-135 Aircraft

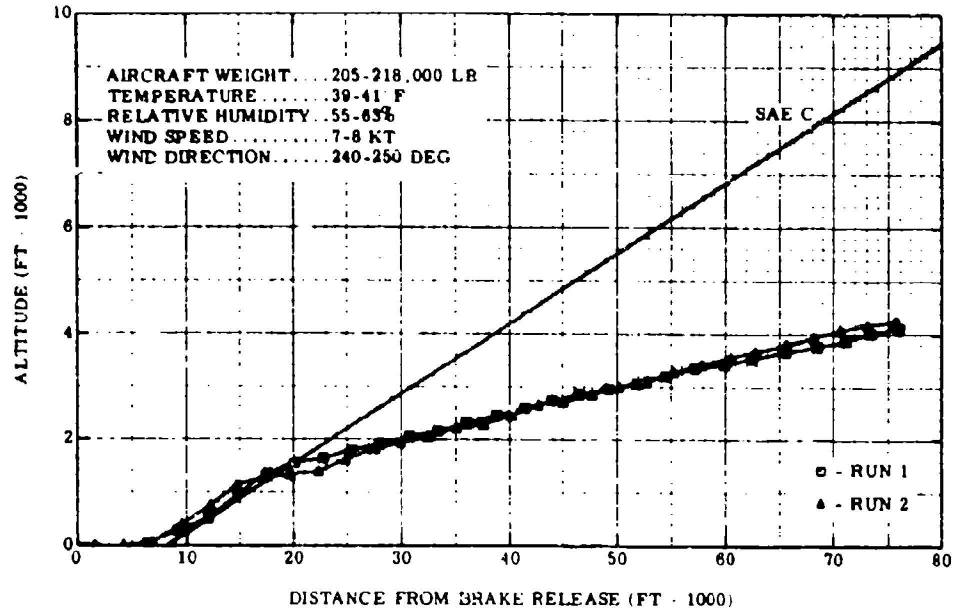

Figure B-23. Takeoff Profile T6, KC-135 Aircraft

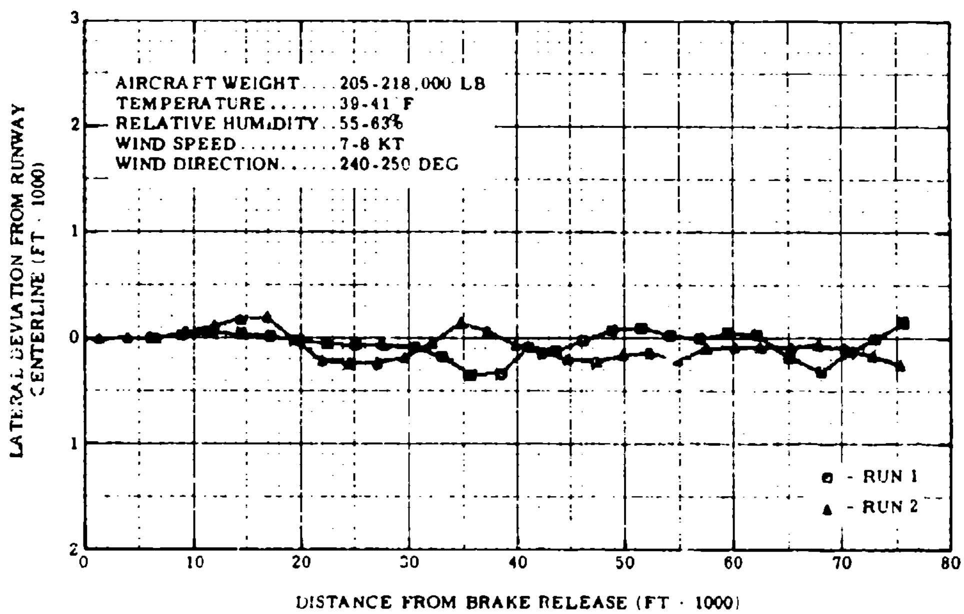

Figure B-24. Takeoff Lateral Deviation T6, KC-135 Aircraft

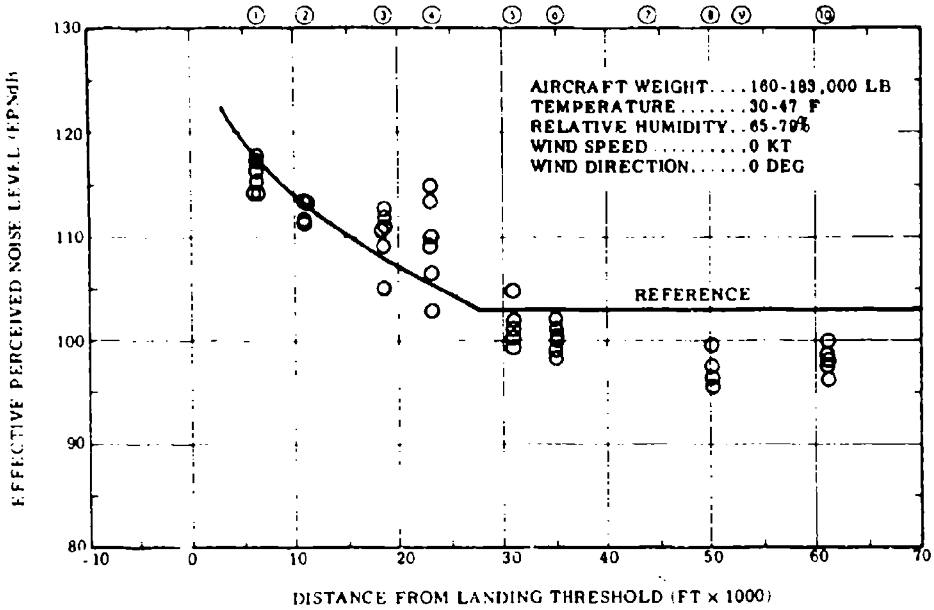

Figure B-25. Approach Noise Levels for Profile A11A, KC-135 Aircraft

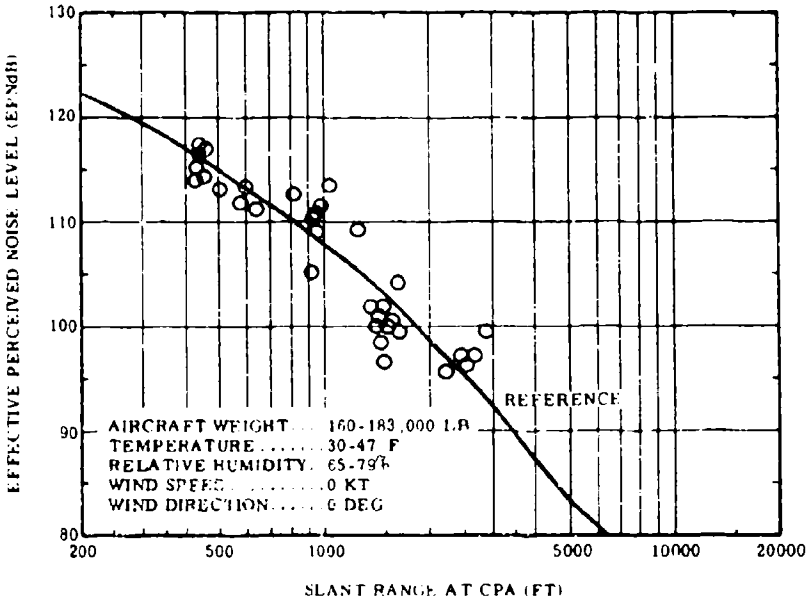

Figure B-26. Noise Levels as a Function of Slant Range for Profile A11A, KC-135 Aircraft

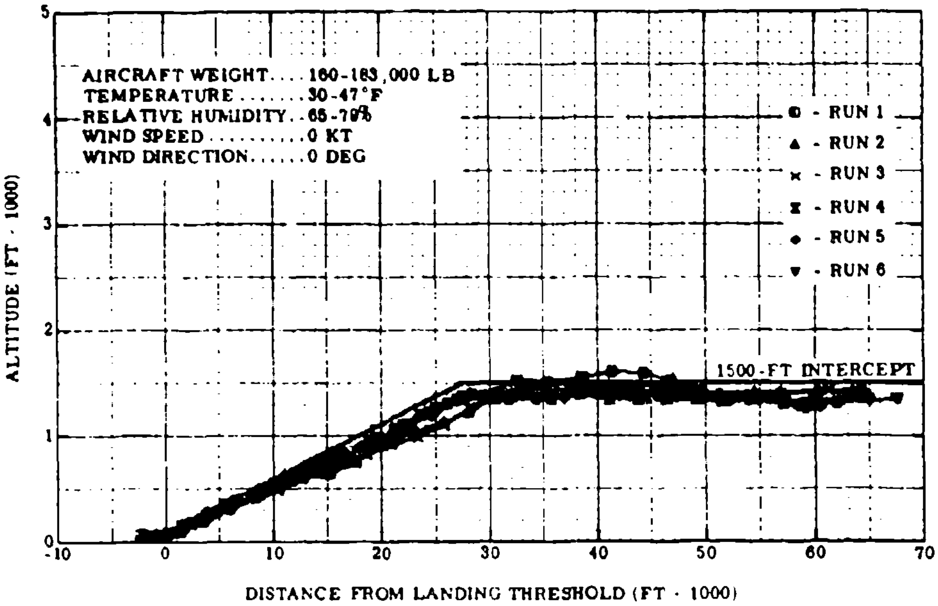

Figure B-27. Approach Profile A11A, KC-135 Aircraft

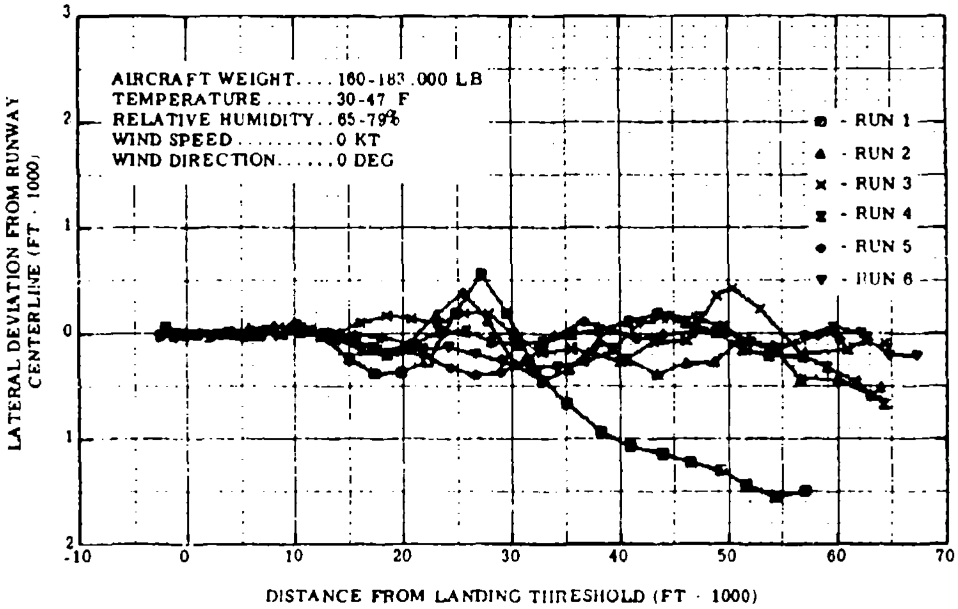

Figure B-28. Approach Lateral Deviation A11A, KC-135 Aircraft

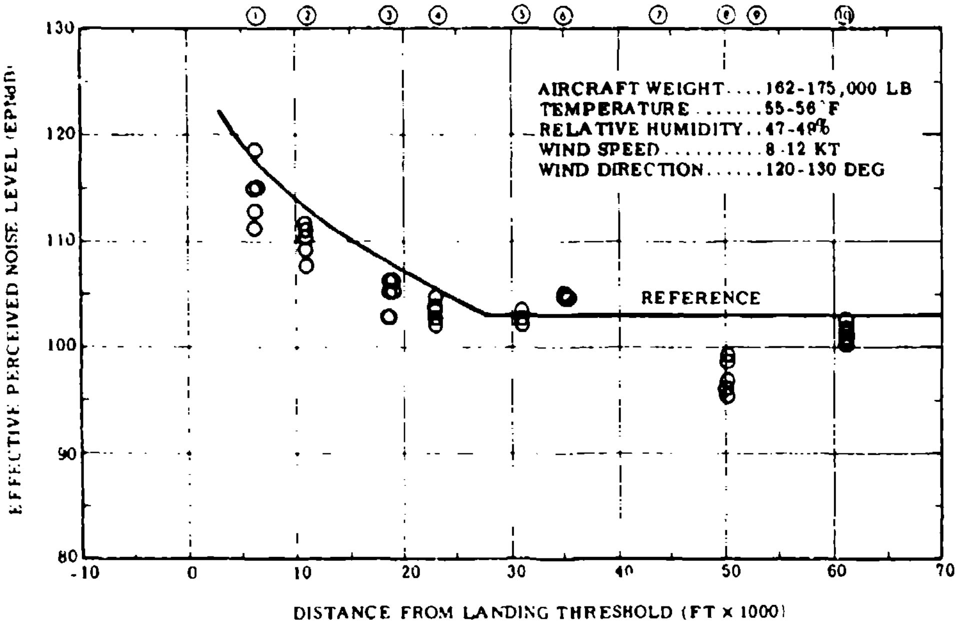

Figure B-29. Approach Noise Levels for Profile A12, KC-135 Aircraft

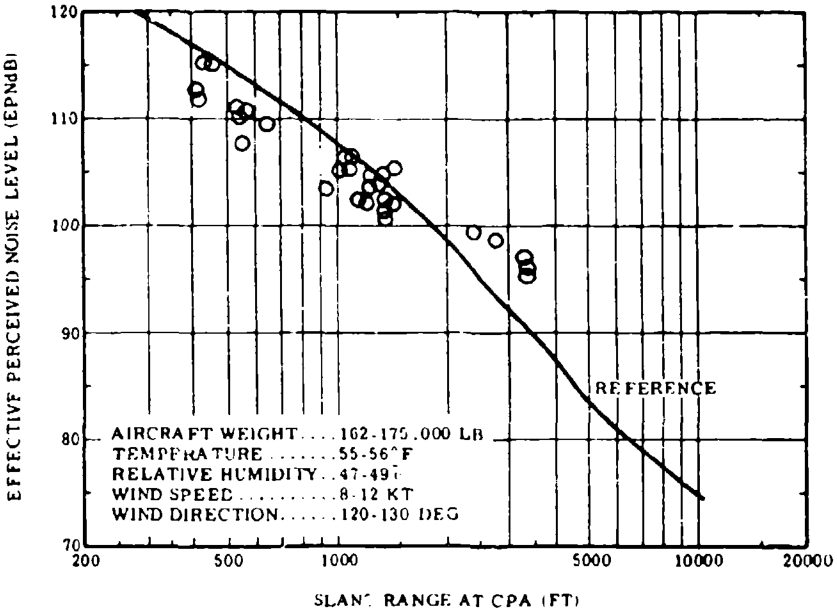

Figure B-30. Noise Levels as a Function of Slant Range for Profile A12, KC-135 Aircraft

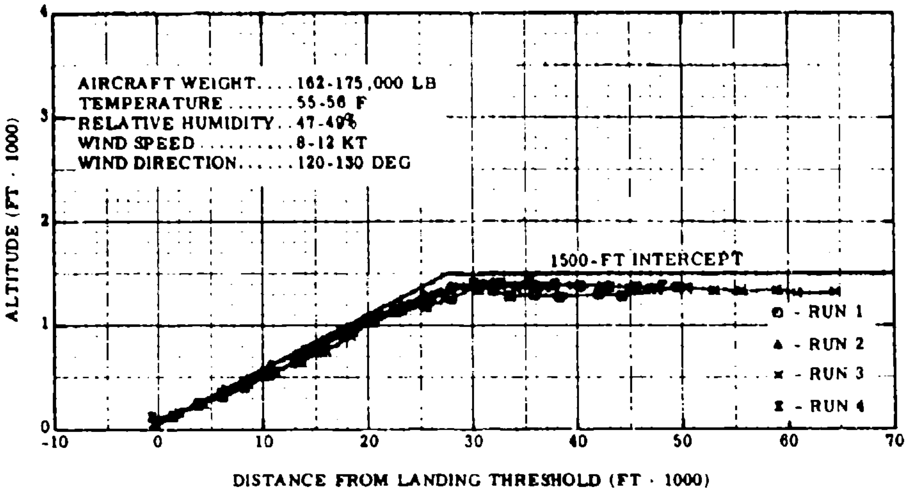

Figure B-31. Approach Profile A12, KC-135 Aircraft

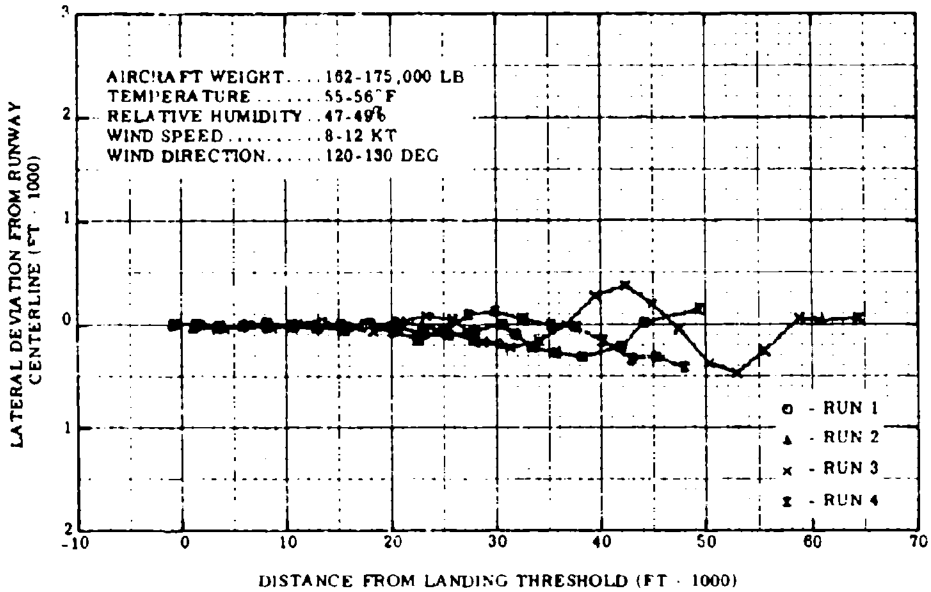

Figure B-32. Approach Lateral Deviation A12, KC-135 Aircraft

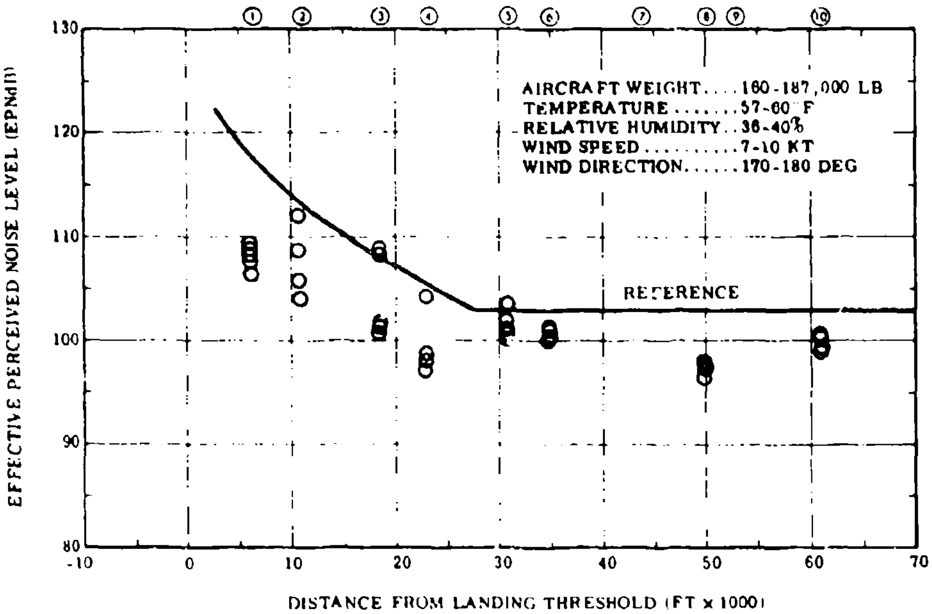

Figure B-33. Approach Noise Levels for Profile A13, KC-135 Aircraft

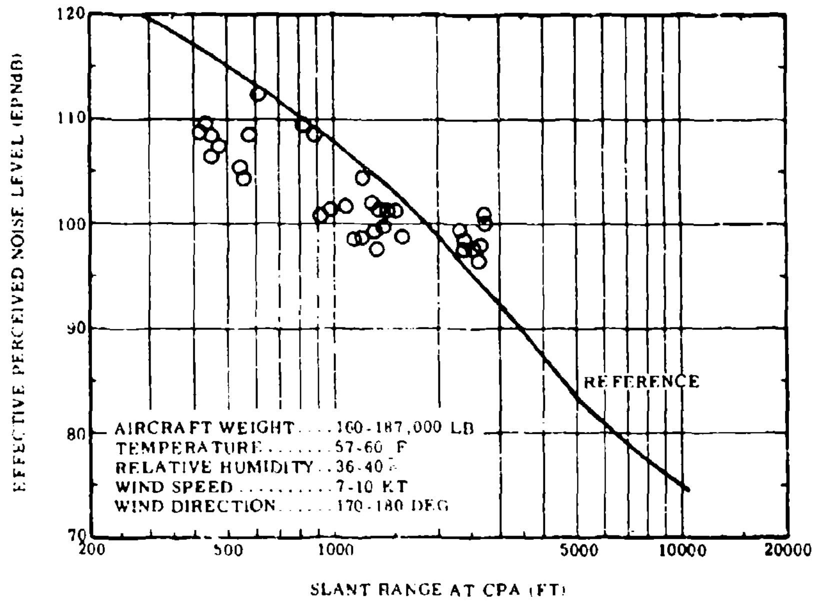

Figure B-34. Noise Levels as a Function of Slant Range for Profile A13, KC-135 Aircraft

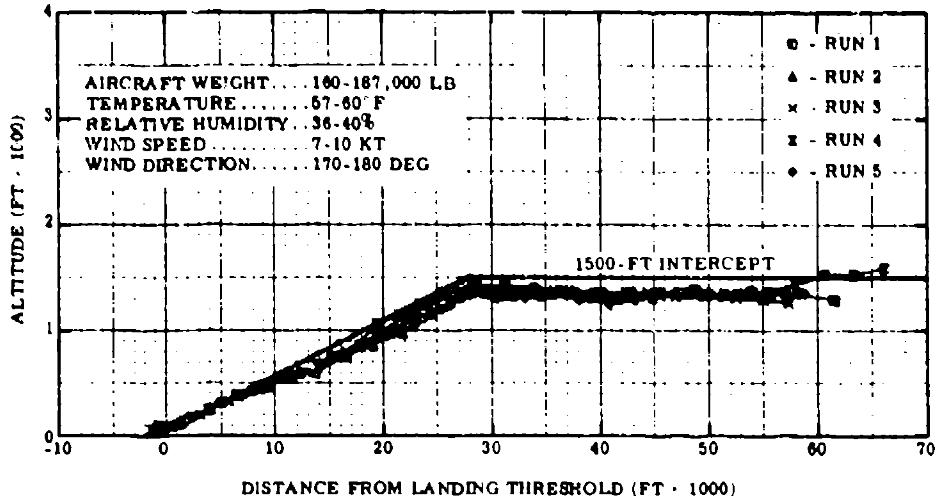

Figure B-35. Approach Profile A13, KC-135 Aircraft

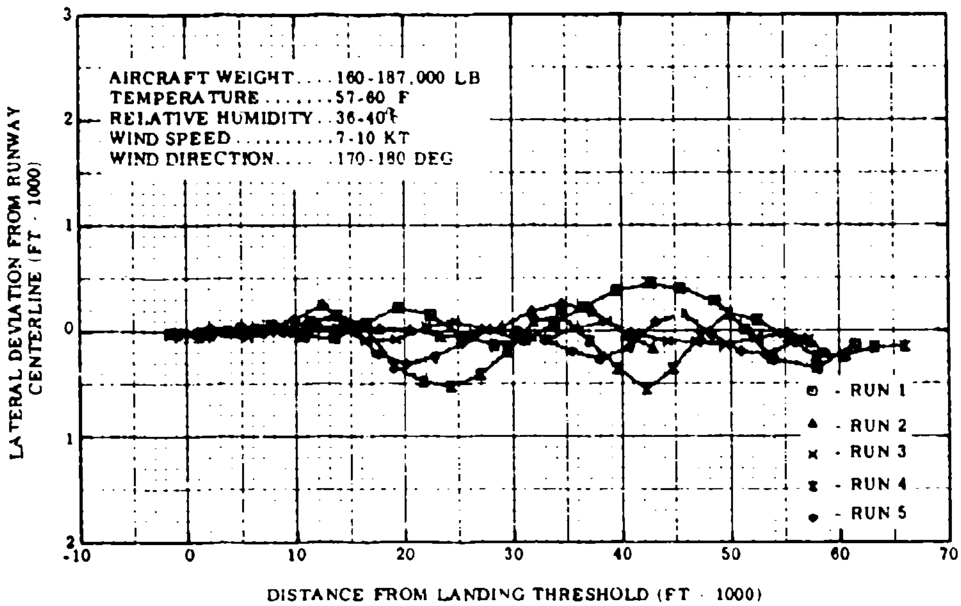

Figure B-36. Approach Lateral Deviation A13, KC-135 Aircraft

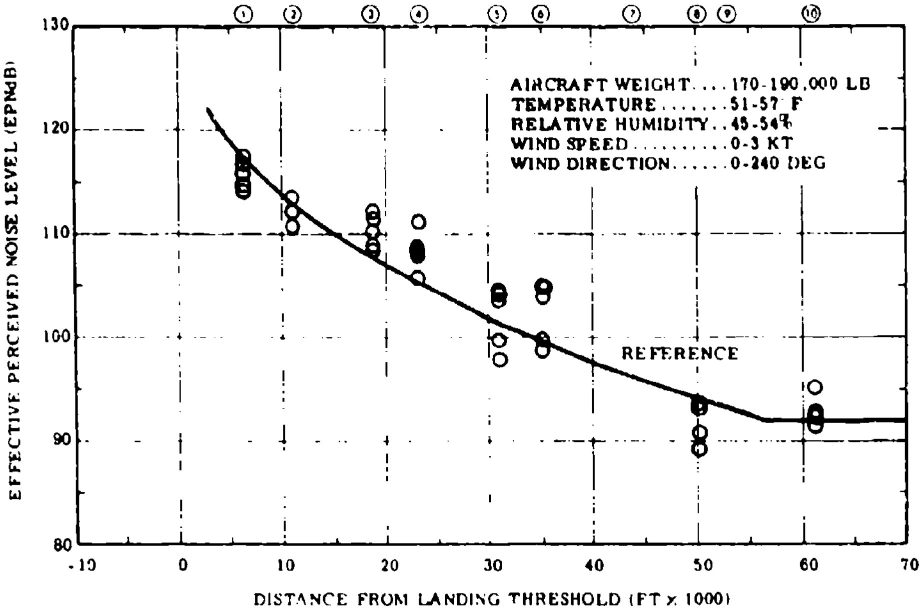

Figure B-37. Approach Noise Levels for Profile A21, KC-135 Aircraft

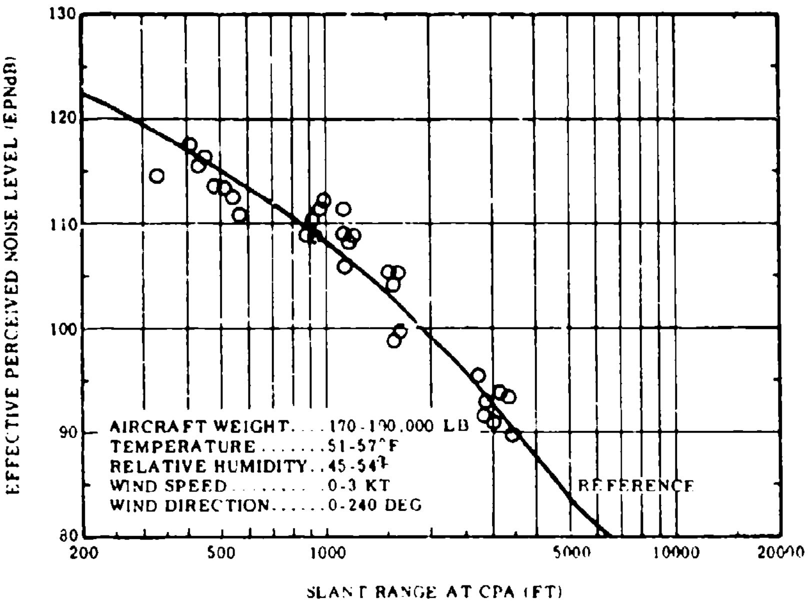

Figure B-38. Noise Levels as a Function of Slant Range for Profile A21, KC-135 Aircraft

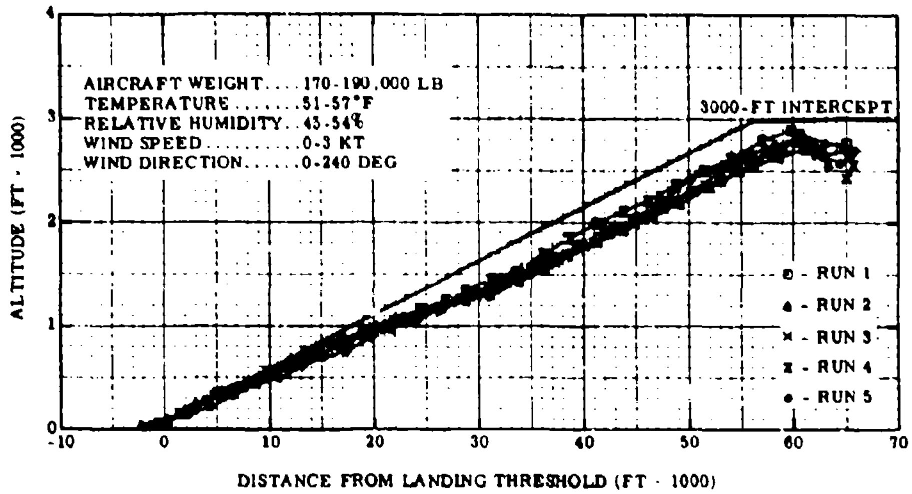

Figure B-39. Approach Profile A21, KC-135 Aircraft

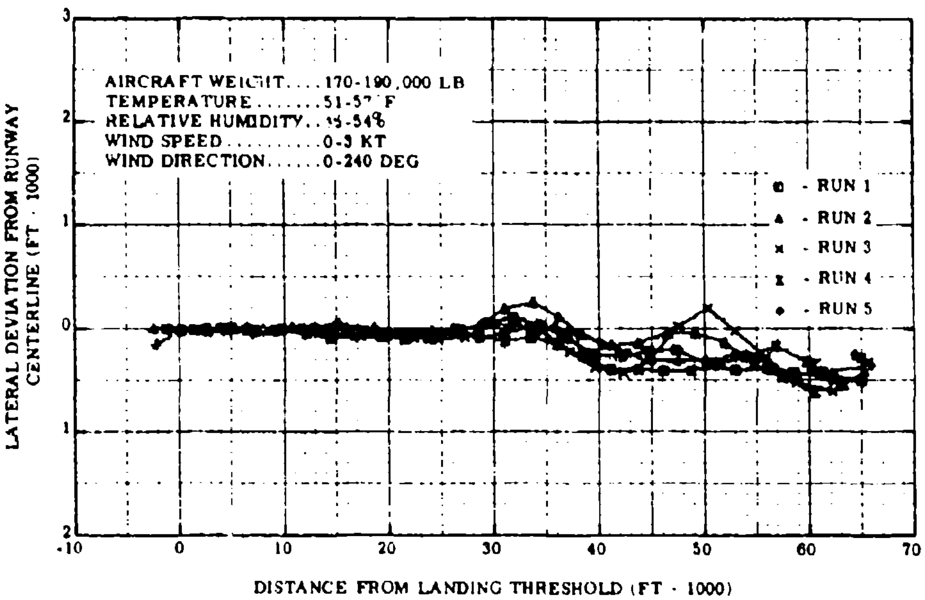

Figure B-40. Approach Lateral Deviation A21, KC-135 Aircraft

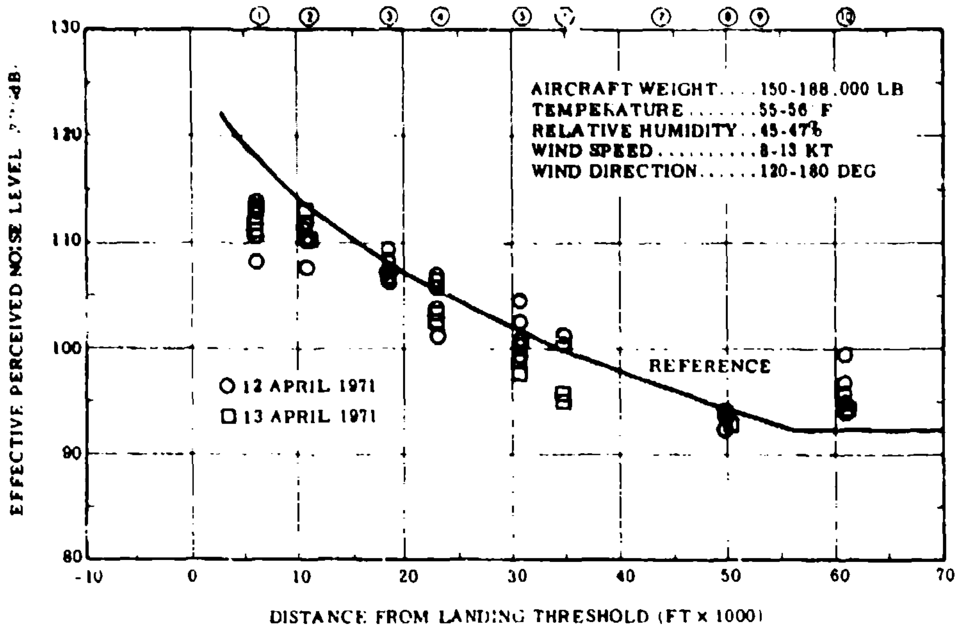

Figure B-41. Approach Noise Levels for Profile A22, KC-135 Aircraft

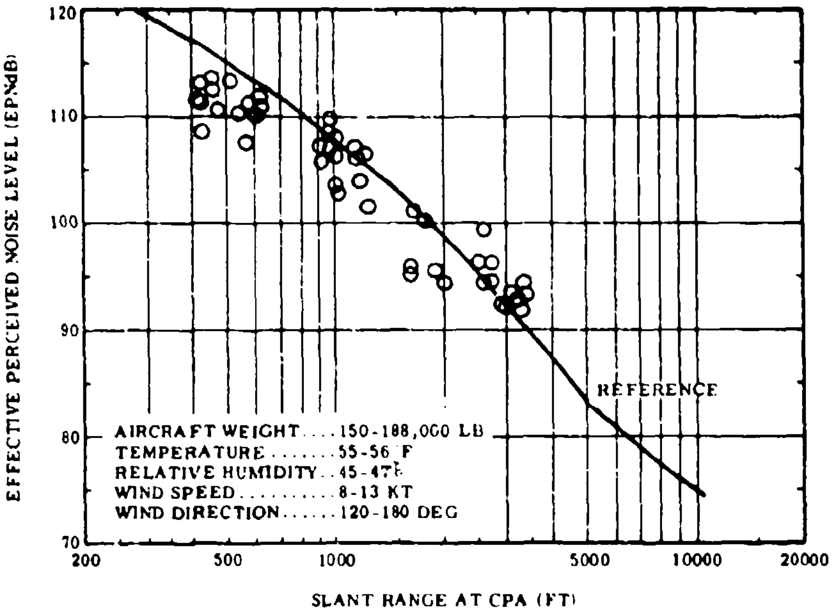

Figure B-42. Noise Levels as a Function of Slant Range for Profile A22, KC-135 Aircraft

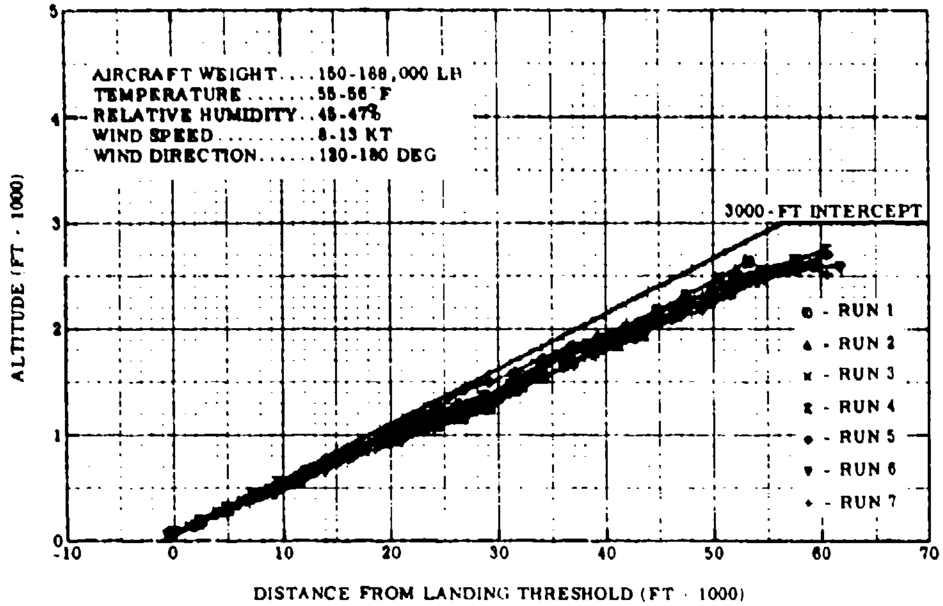

Figure B-43. Approach Profile A22, KC-135 Aircraft

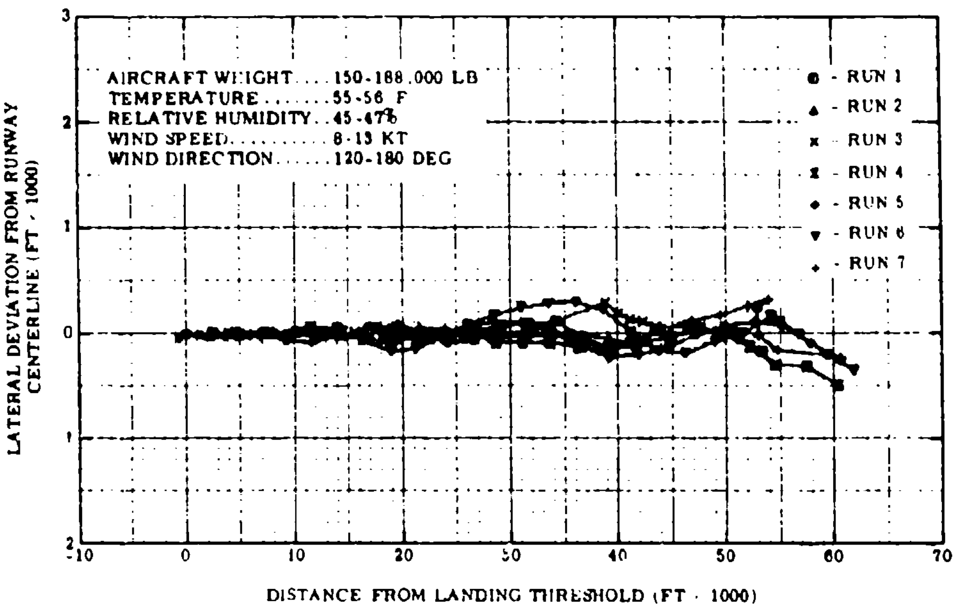

Figure B-44. Approach Lateral Deviation A22, KC-135 Aircraft

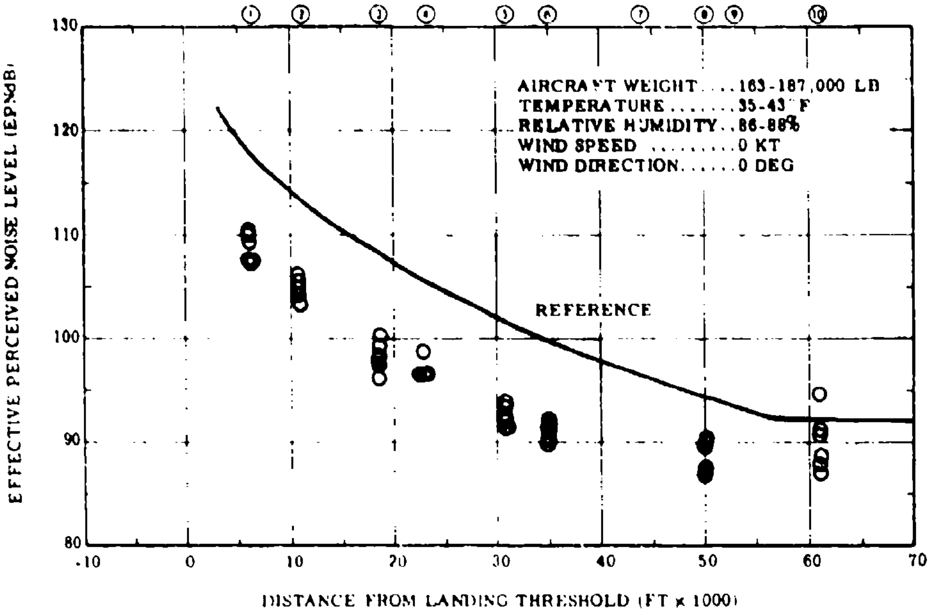

Figure B-45. Approach Noise Levels for Profile A23, KC-135 Aircraft

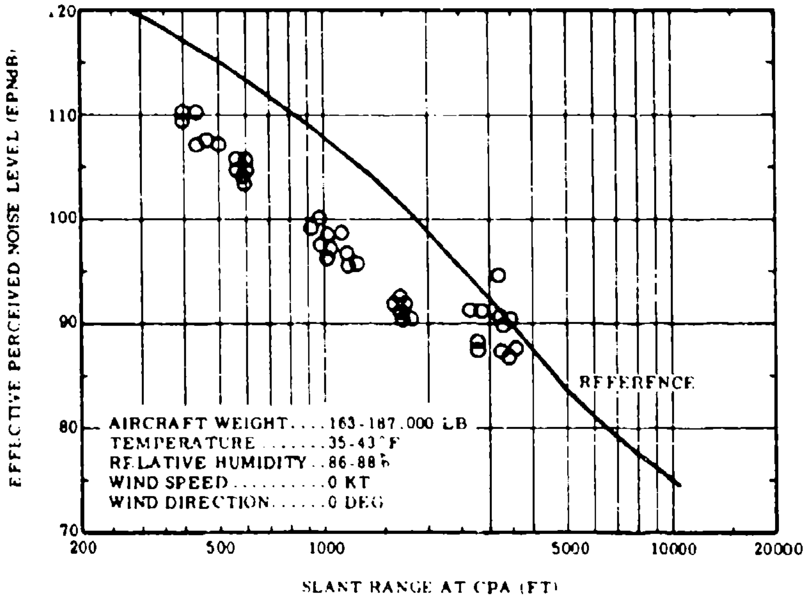

Figure B-46. Noise Levels as a Function of Slant Range for Profile A23, KC-135 Aircraft

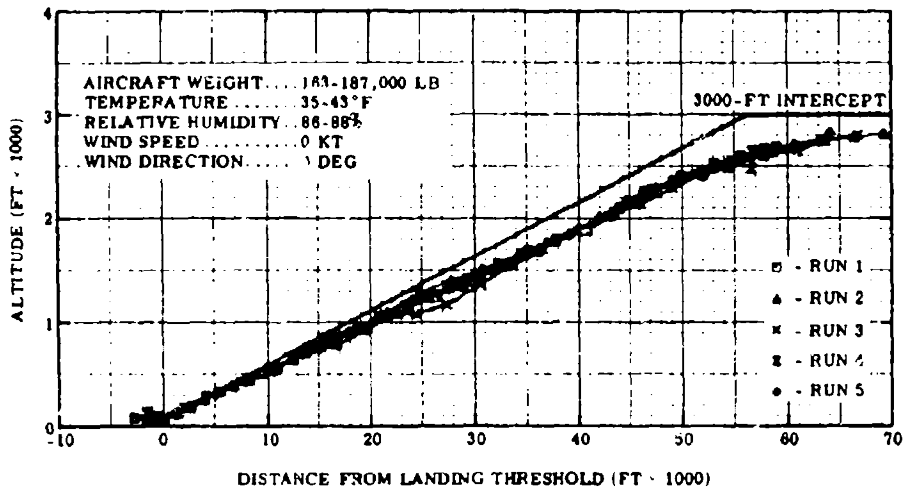

Figure B-47. Approach Profile A23, KC-135 Aircraft

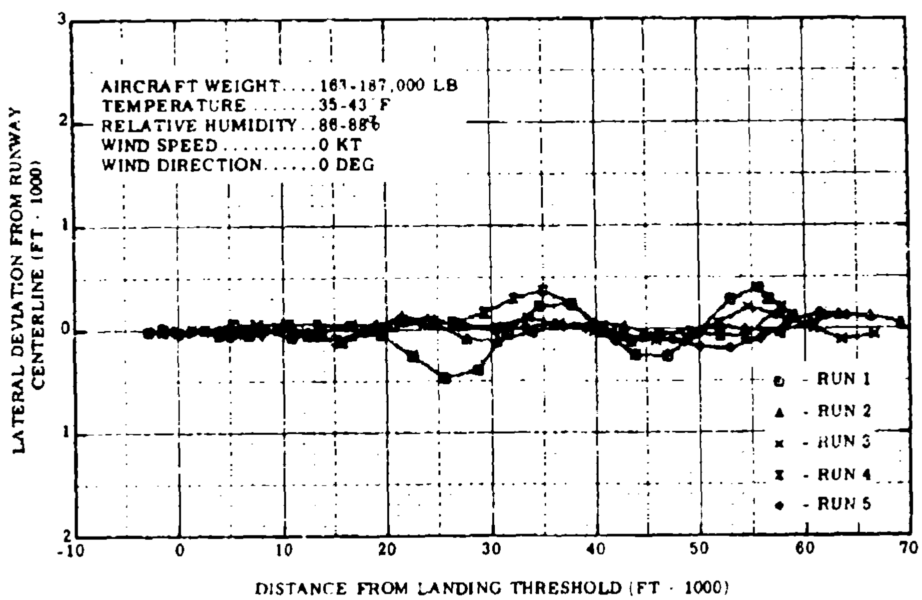

Figure B-48. Approach Lateral Deviation A23, KC-135 Aircraft

Appendix C

707-320B AIRCRAFT
DETAILED NOISE AND TRACKING PLOTS

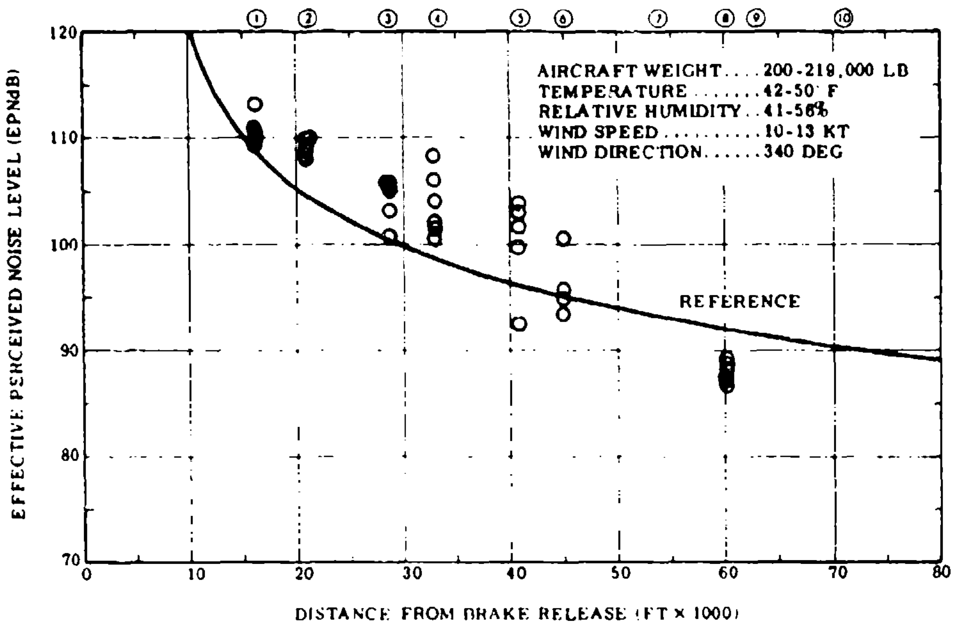

Figure C-1. Takeoff Noise Levels for Profile T1, 707-320B Aircraft

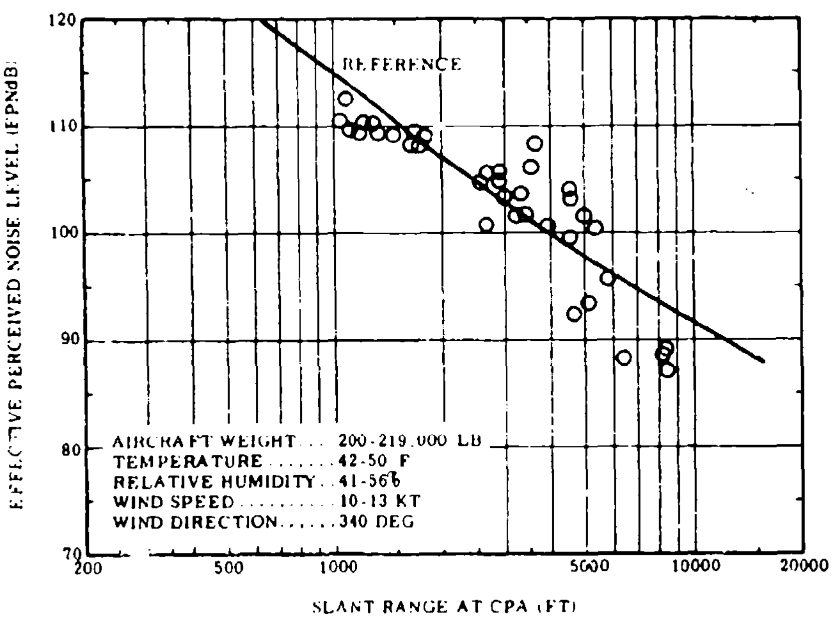

Figure C-2. Noise Levels as a Function of Slant Range for Profile T1, 707-320B Aircraft

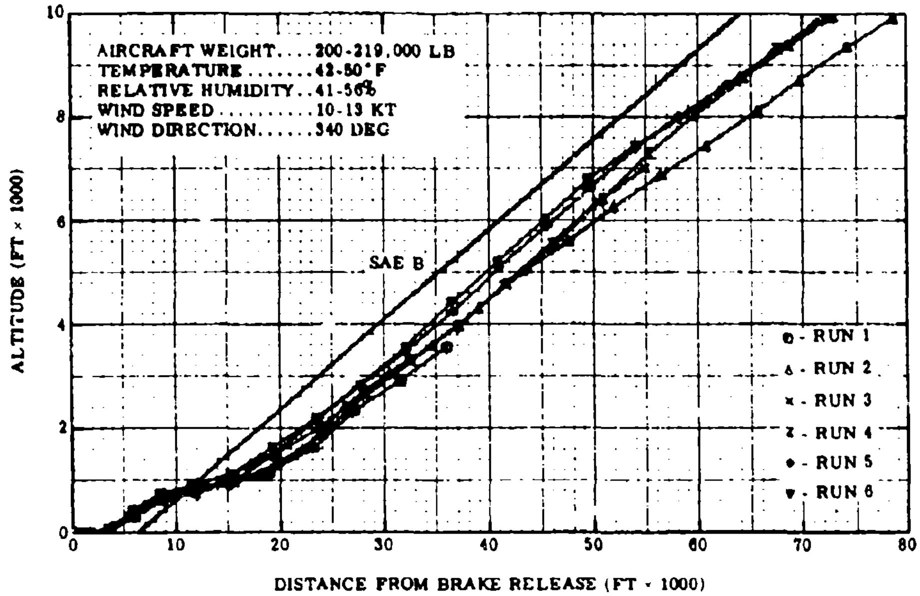

Figure C-3. Takeoff Profile T1, 707-320B Aircraft

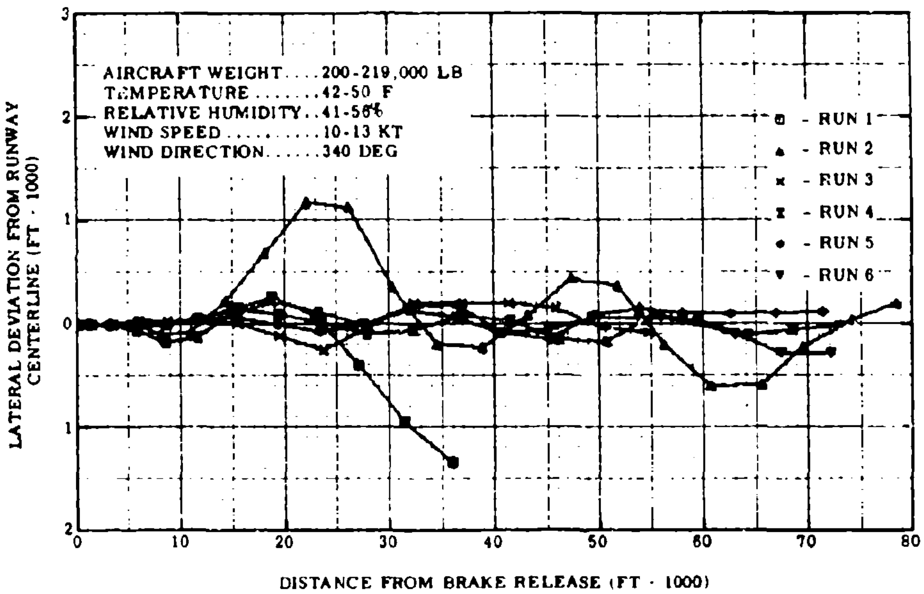

Figure C-4. Takeoff Lateral Deviation T1, 707-320B Aircraft

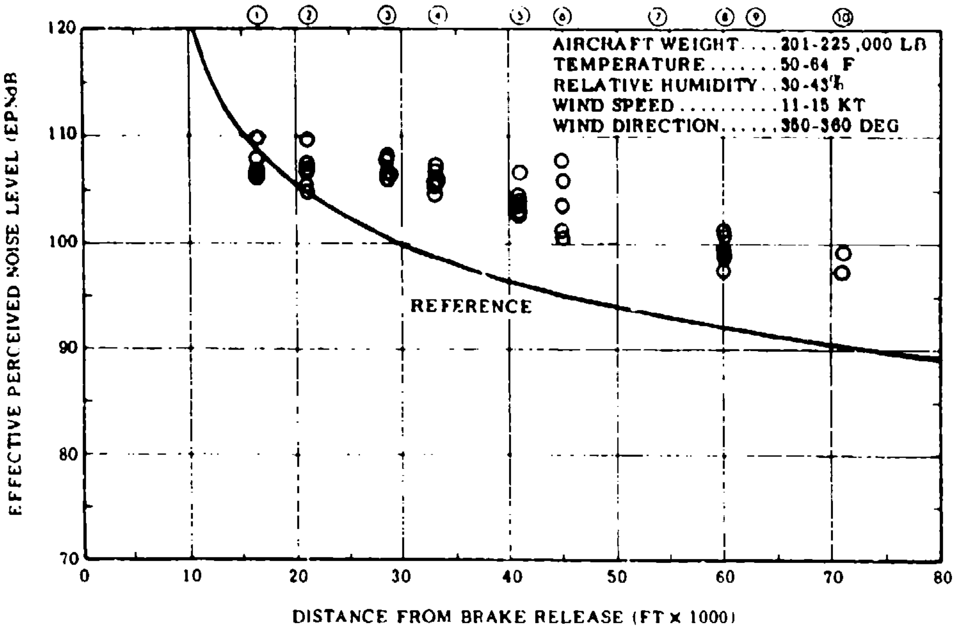

Figure C-5. Takeoff Noise Levels for Profile T2, 707-320B Aircraft

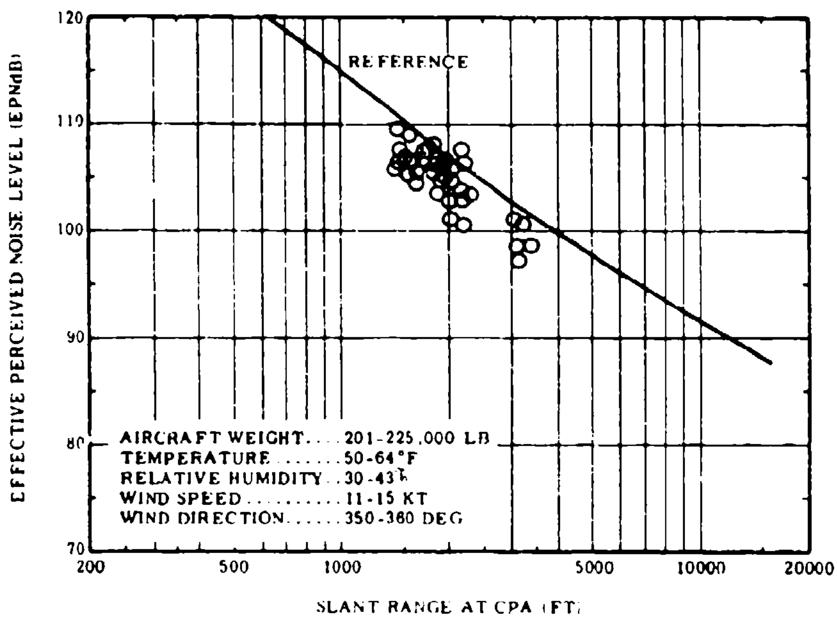

Figure C-6. Noise Levels as a Function of Slant Range for Profile T2, 707-320B Aircraft

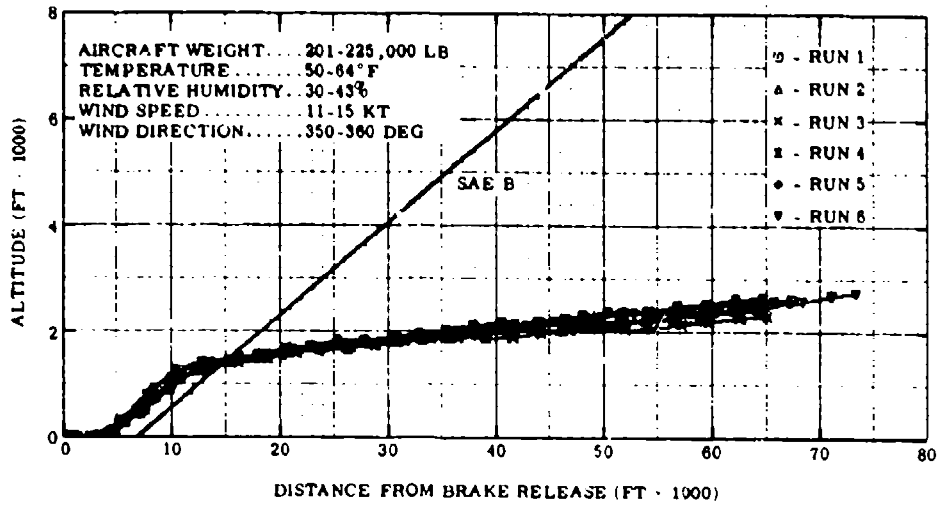

Figure C-7. Takeoff Profile T2, 707-320B Aircraft

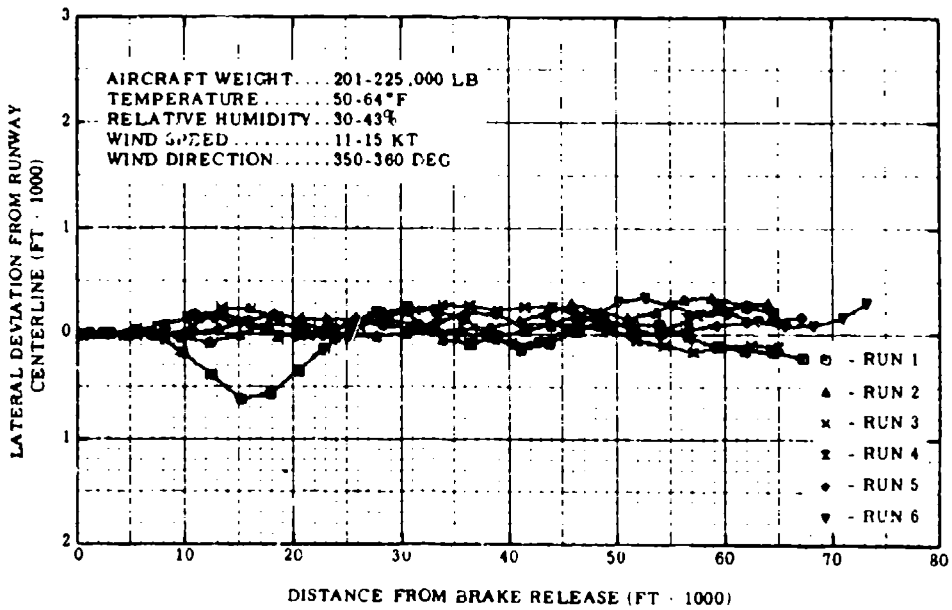

Figure C-8. Takeoff Lateral Deviation T2, 707-320B Aircraft

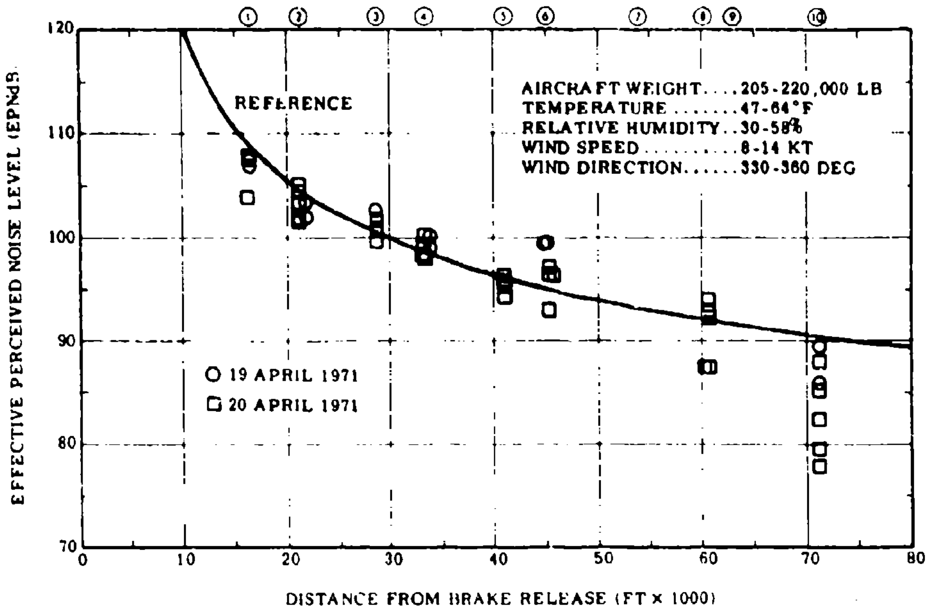

Figure C-9. Takeoff Noise Levels for Profile T3, 707-320B Aircraft

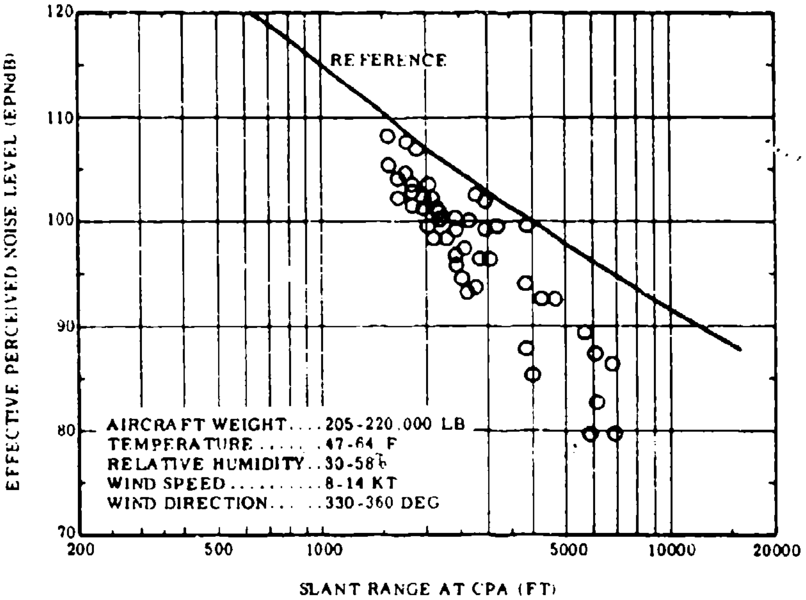

Figure C-10. Noise Levels as a Function of Slant Range for Profile T3, 707-320B Aircraft

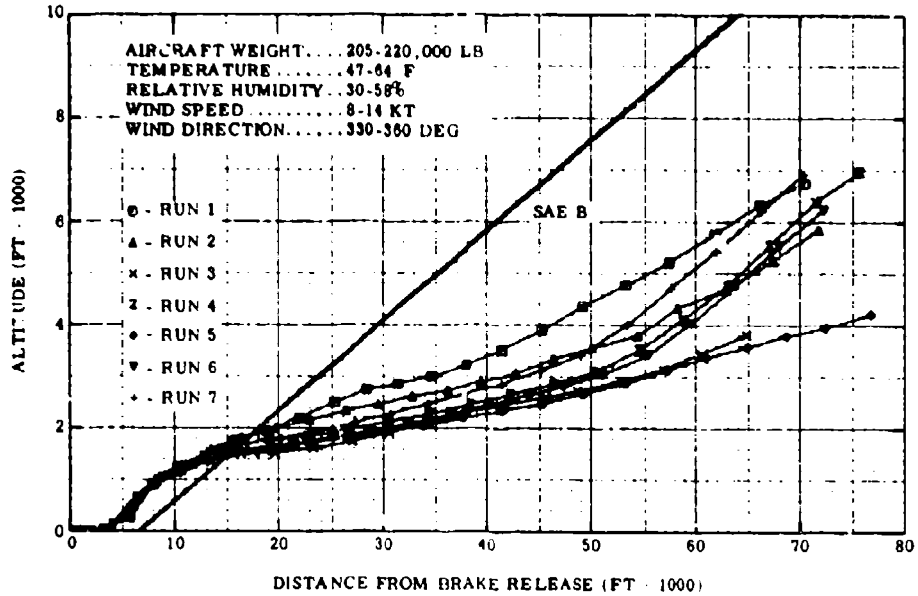

Figure C-11. Takeoff Profile T3, 707-320B Aircraft

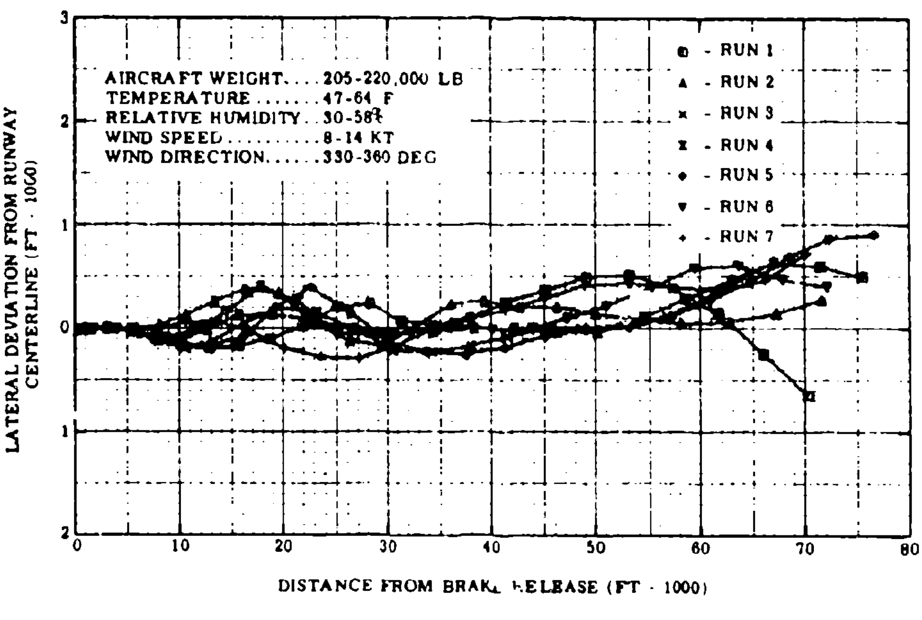

Figure C-12. Takeoff Lateral Deviation T3, 707-320B Aircraft

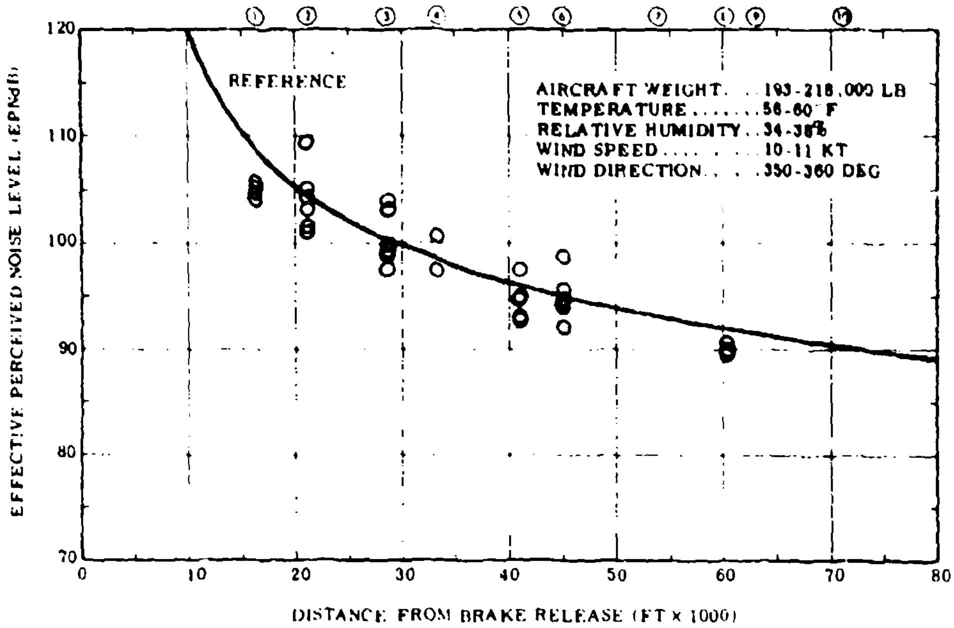

Figure C-13. Takeoff Noise Levels for Profile T4, 707-320B Aircraft

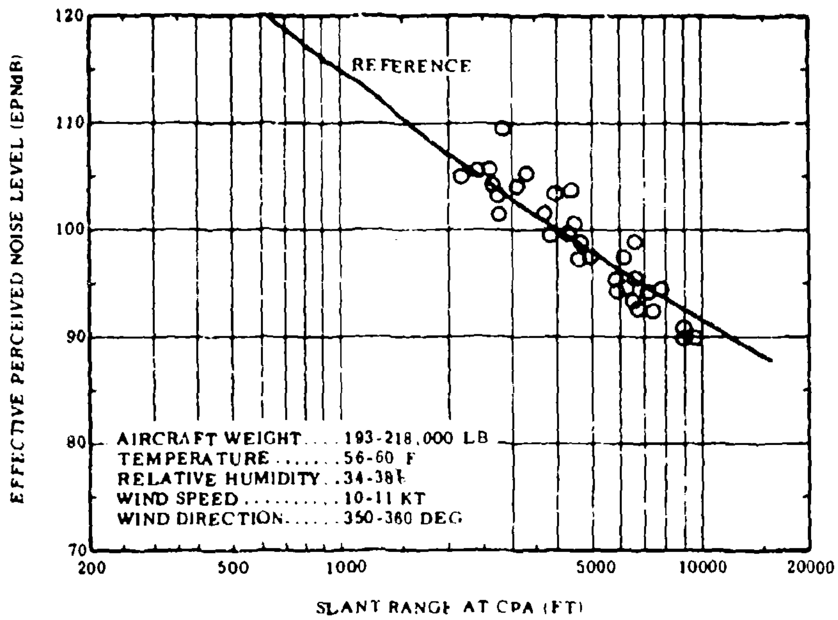

Figure C-14. Noise Levels as a Function of Slant Range for Profile T4, 707-320B Aircraft

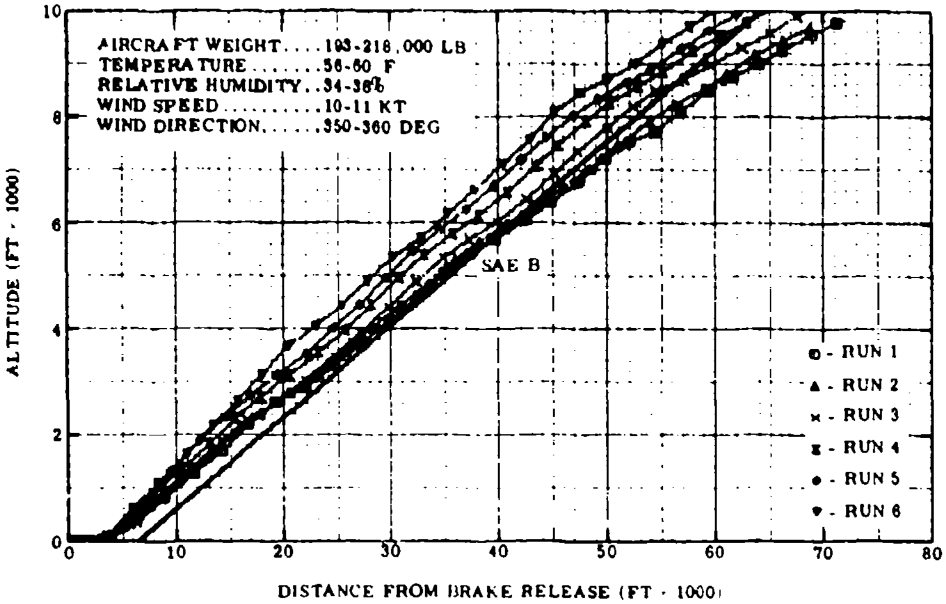

Figure C-15. Takeoff Profile T4, 707-320B Aircraft

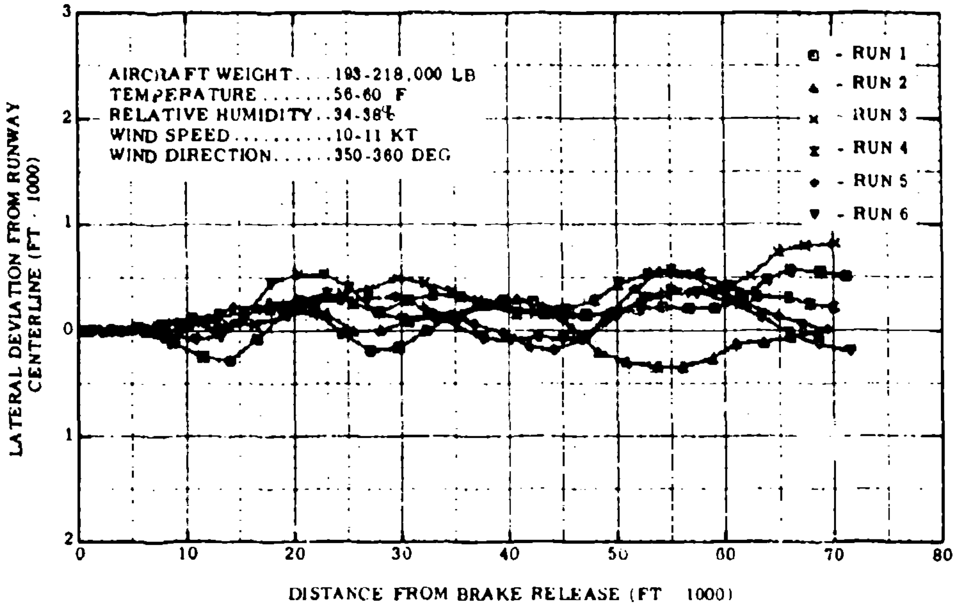

Figure C-16. Takeoff Lateral Deviation T4, 707-320B Aircraft

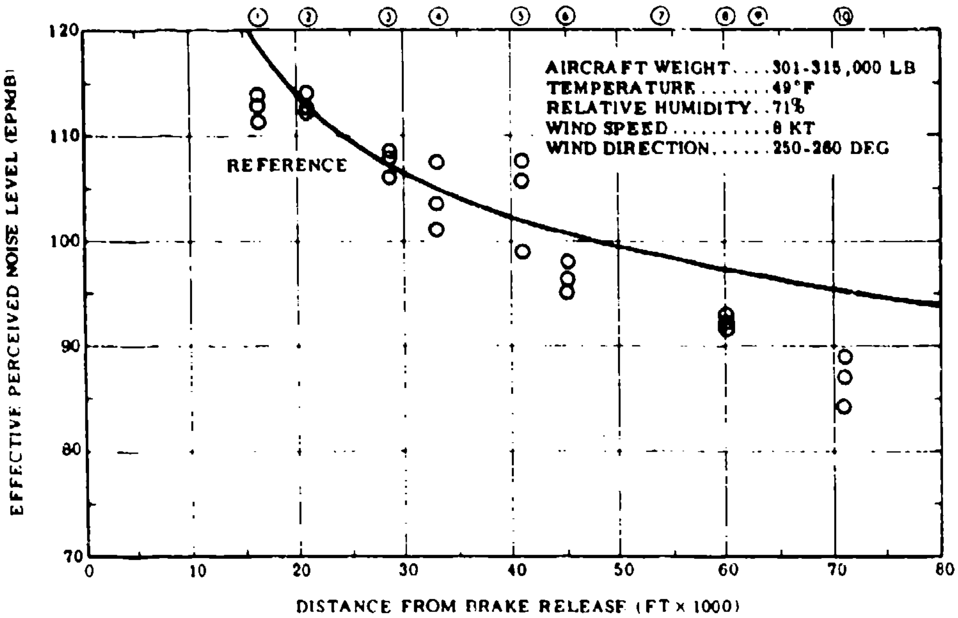

Figure C-17. Takeoff Noise Levels for Profile T5, 707-320B Aircraft

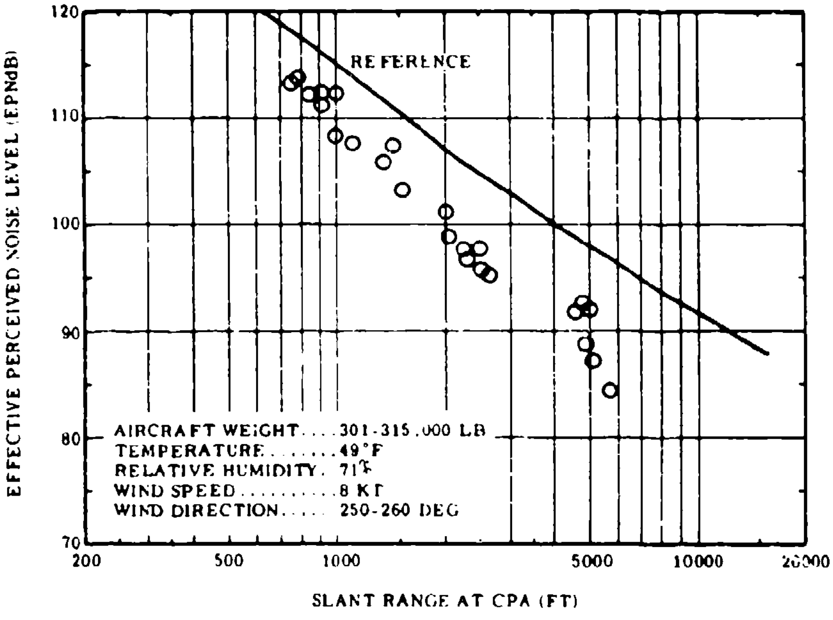

Figure C-18. Noise Levels as a Function of Slant Range for Profile T5, 707-320B Aircraft

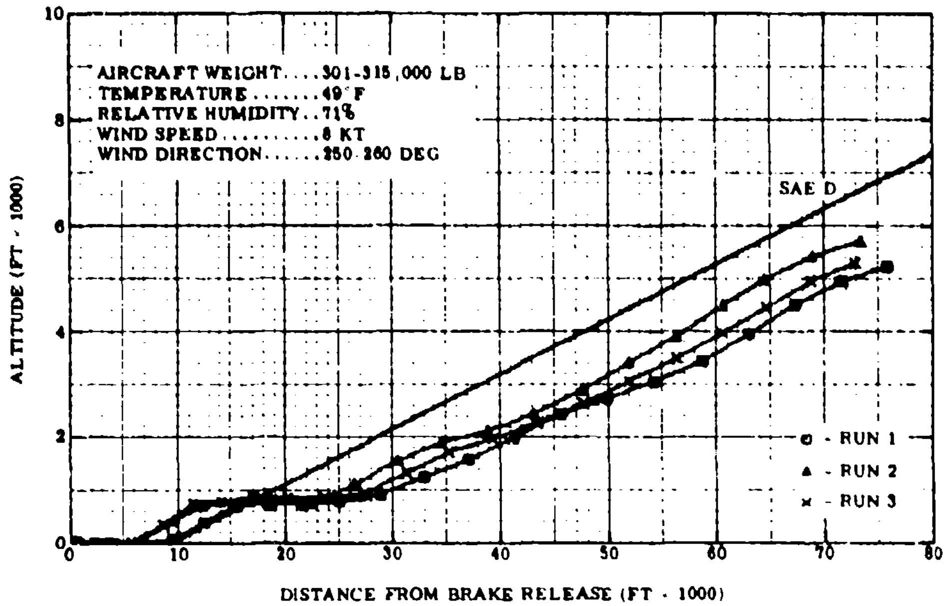

Figure C-19. Takeoff Profile T5, 707-320B Aircraft

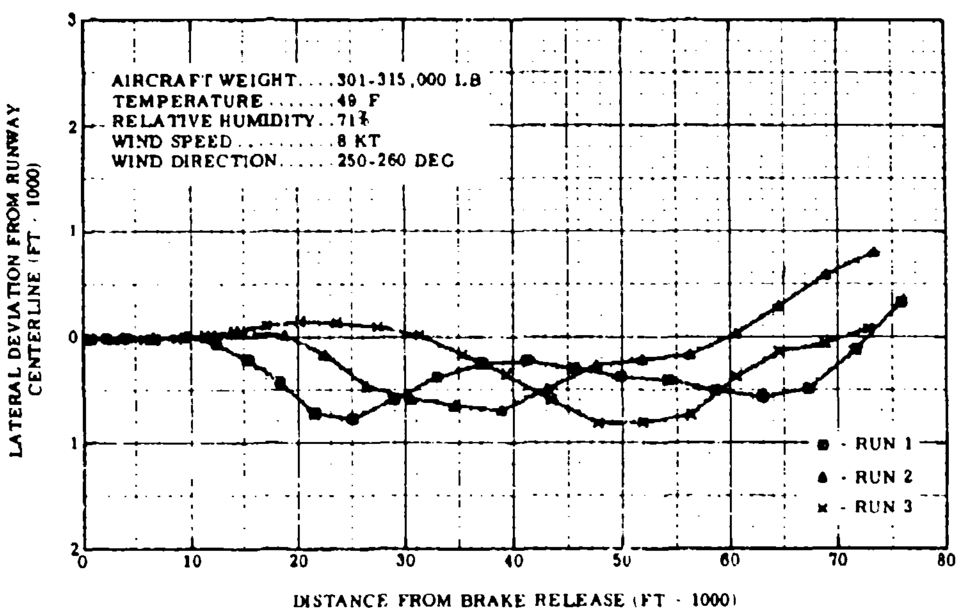

Figure C-20. Takeoff Lateral Deviation T5, 707-320B Aircraft

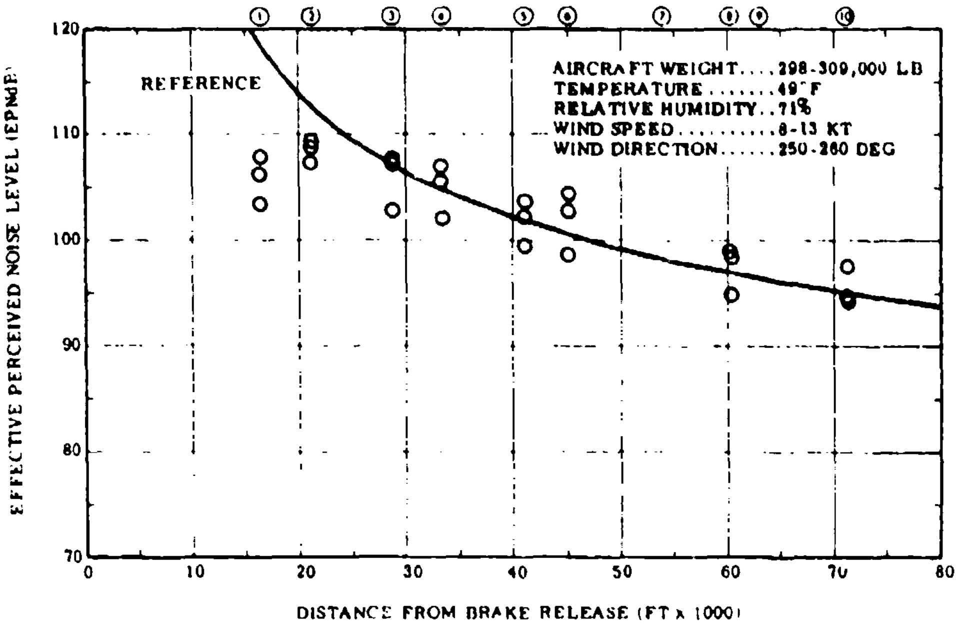

Figure C-21. Takeoff Noise Levels for Profile T6, 707-320B Aircraft

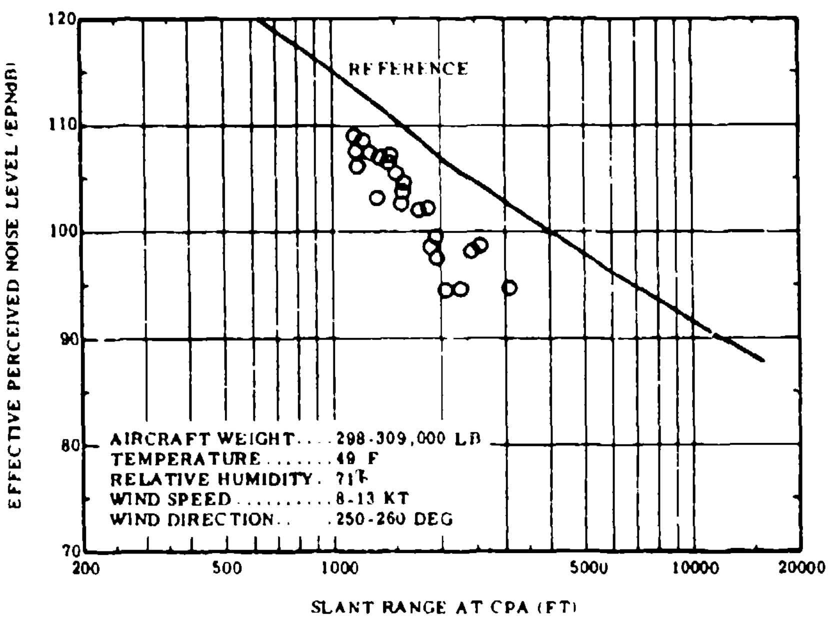

Figure C-22. Noise Levels as a Function of Slant Range for Profile T6, 707-320B Aircraft

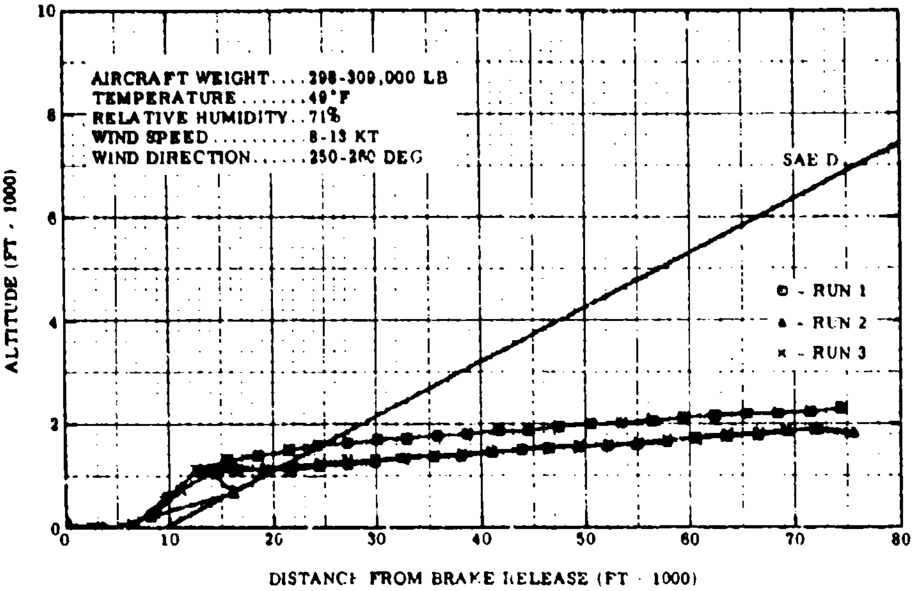

Figure C-23. Takeoff Profile T6, 707-320B Aircraft

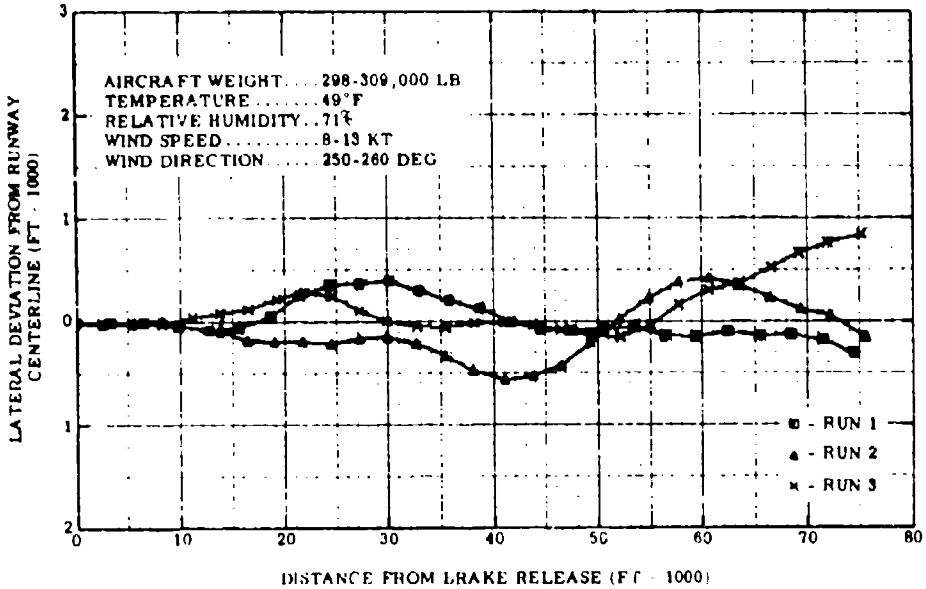

Figure C-24. Takeoff Lateral Deviation T6, 707-320B Aircraft

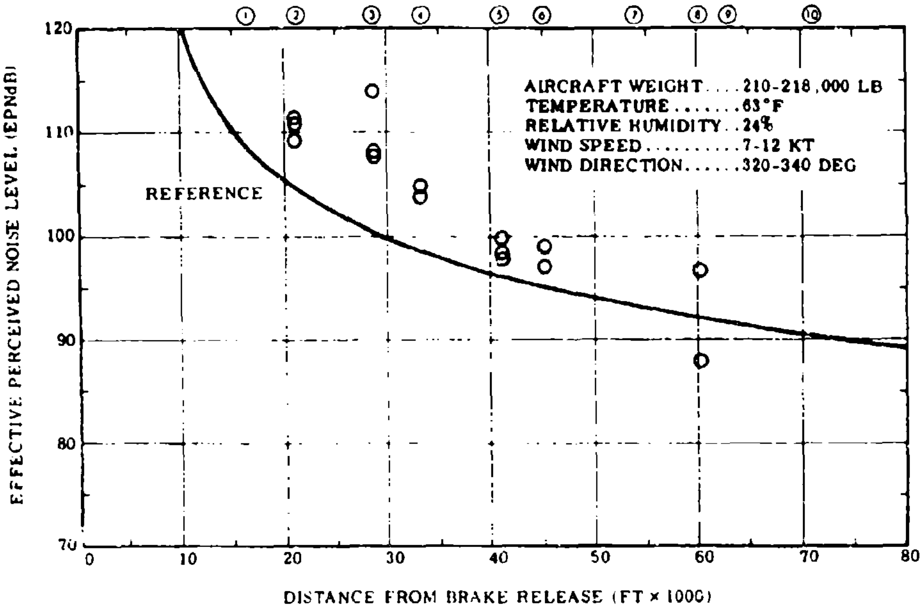

Figure C-25. Takeoff Noise Levels for Profile T8, 707-320B Aircraft

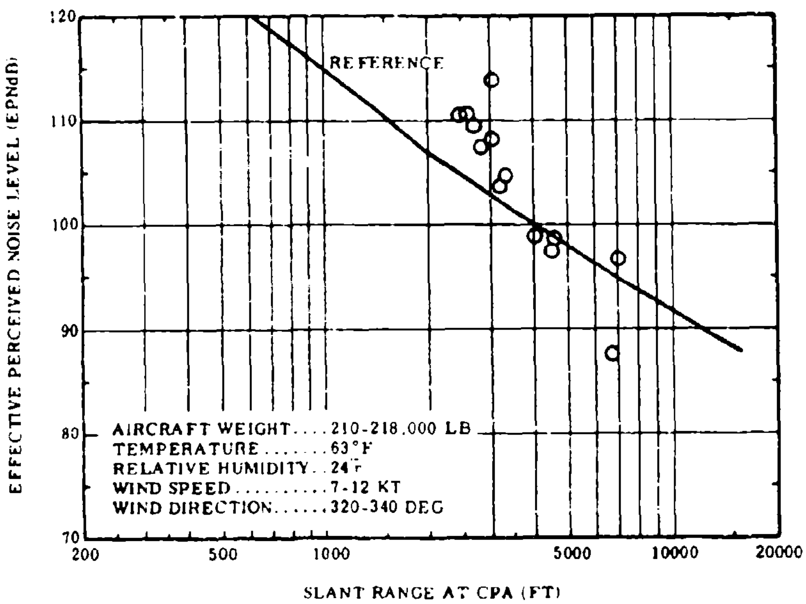

Figure C-26. Noise Levels as a Function of Slant Range for Profile T8, 707-320B Aircraft

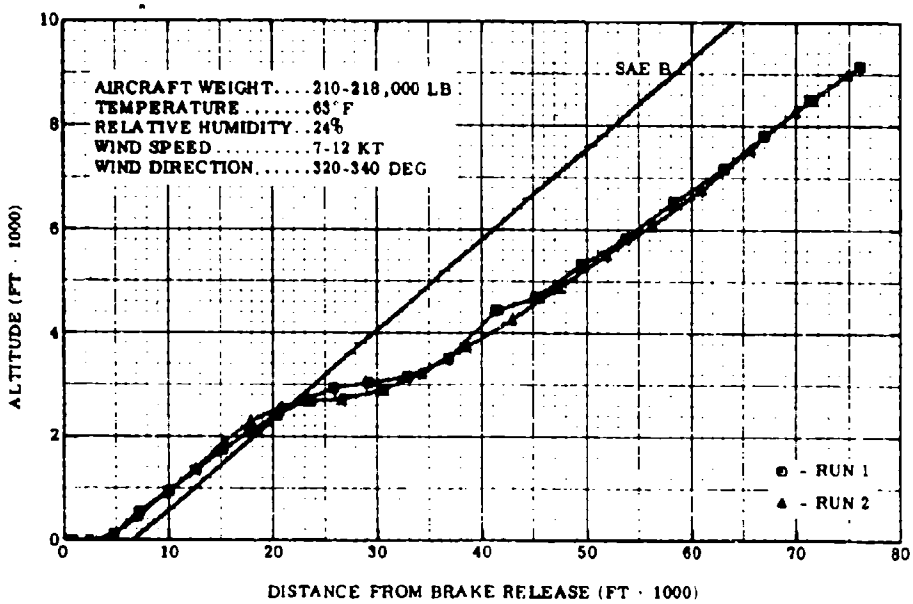

Figure C-27. Takeoff Profile T8, 707-320B Aircraft

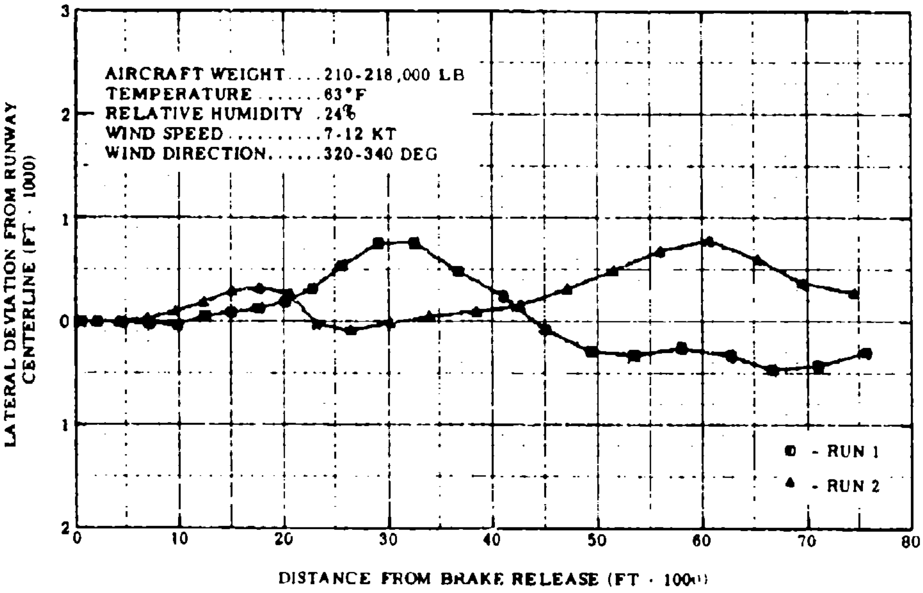

Figure C-28. Takeoff Lateral Deviation T8, 707-320B Aircraft

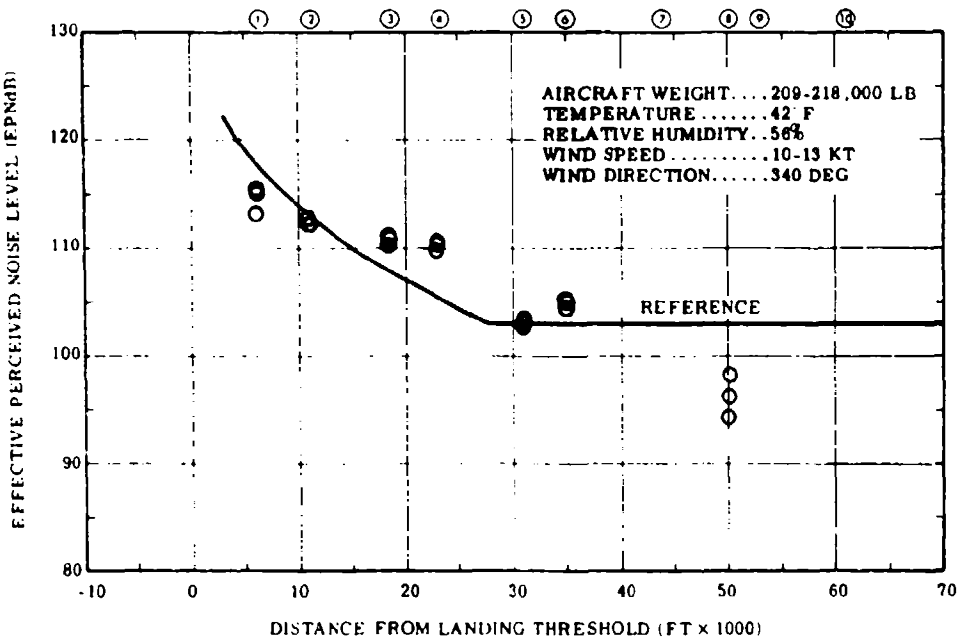

Figure C-29. Approach Noise Levels for Profile A11A, 707-320B Aircraft

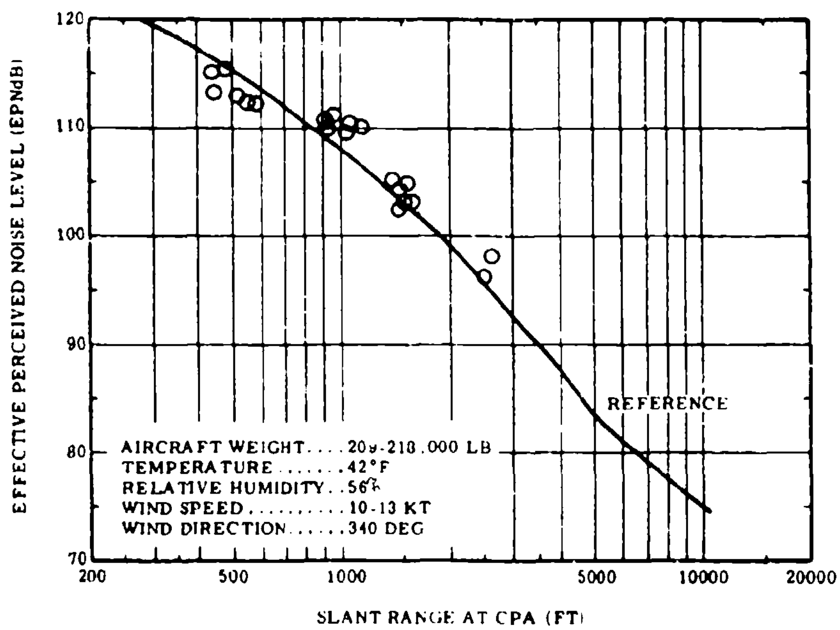

Figure C-30. Noise Levels as a Function of Slant Range for Profile A11A, 707-320B Aircraft

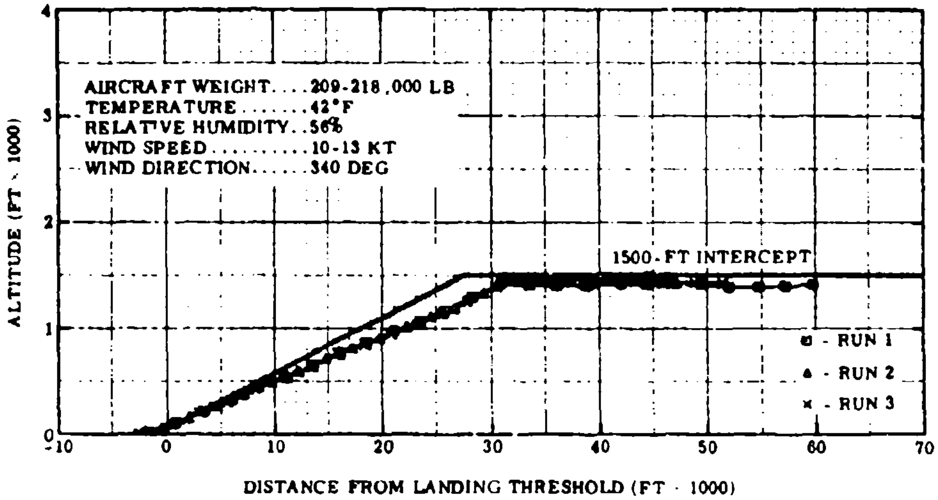

Figure C-31. Approach Profile A11A, 707-320B Aircraft

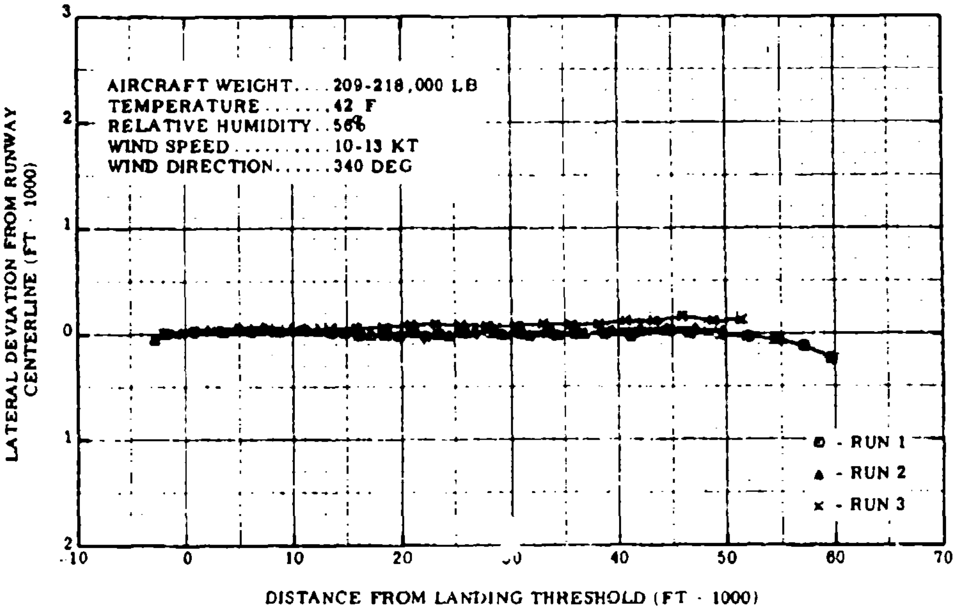

Figure C-32. Approach Lateral Deviation A11A, 707-320B Aircraft

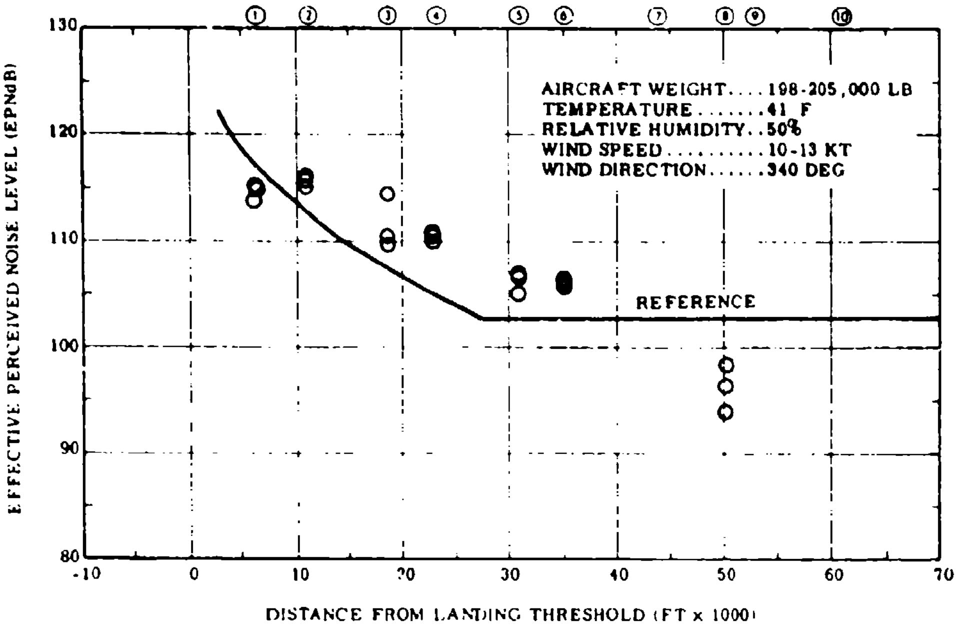

Figure C-33. Approach Noise Levels for Profile A11B, 707-320B Aircraft

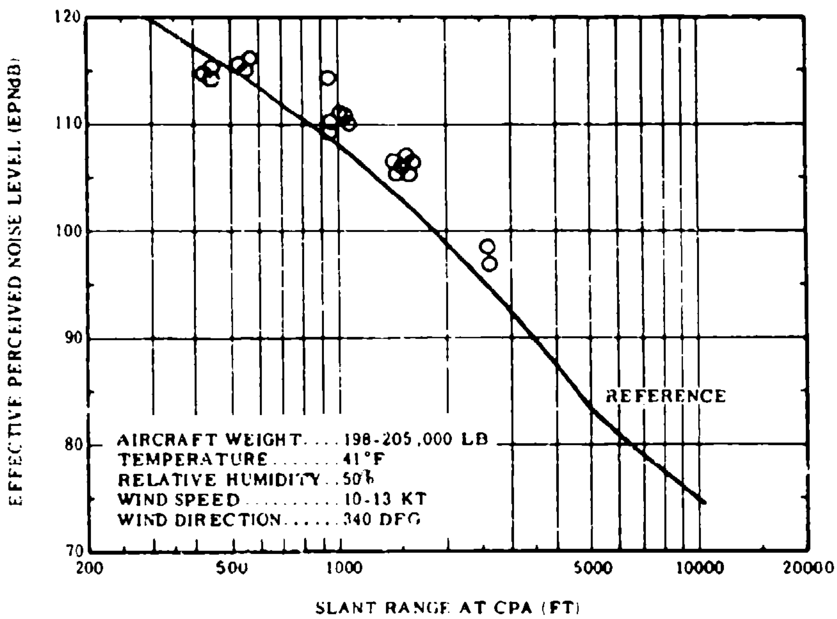

Figure C-34. Noise Levels as a Function of Slant Range for Profile A11B, 707-320B Aircraft

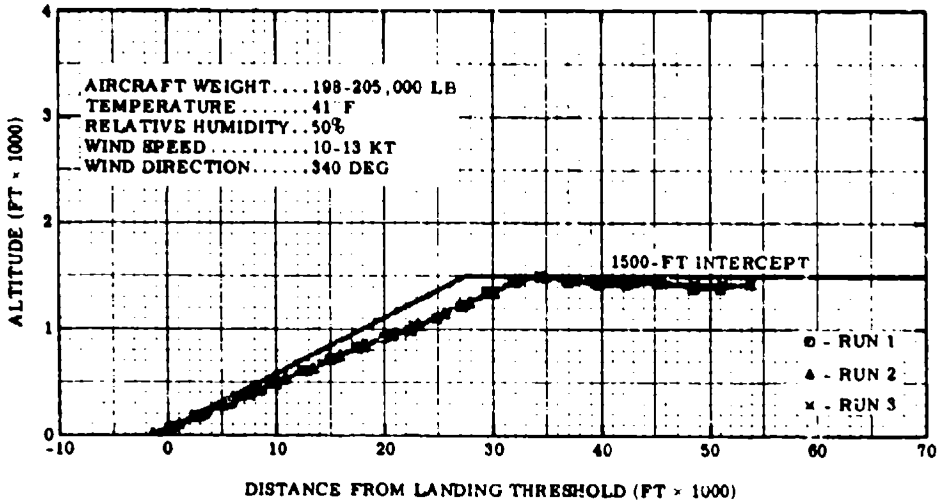

Figure C-35. Approach Profile A11B, 707-320B Aircraft

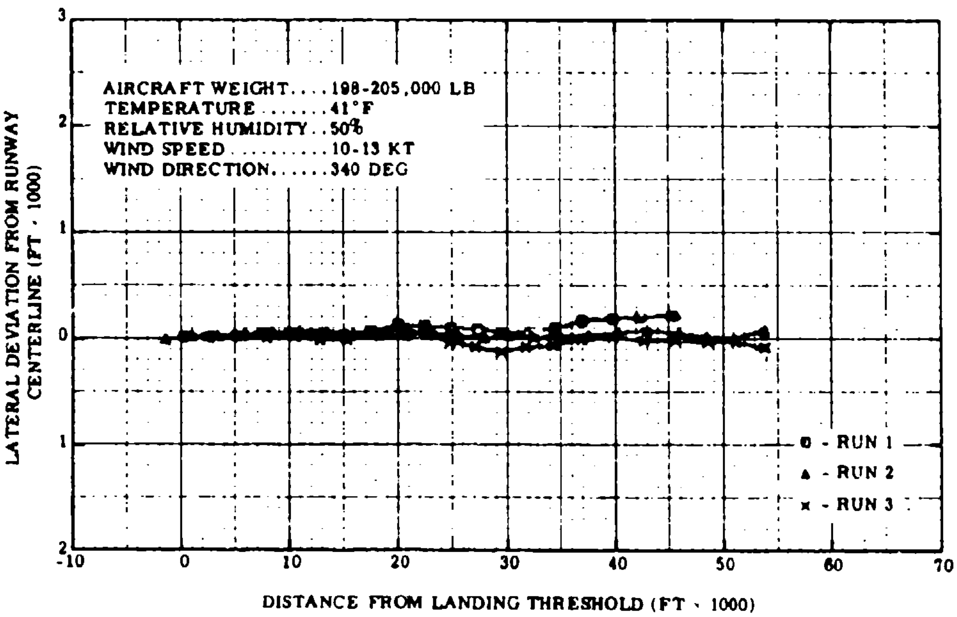

Figure C-36. Approach Lateral Deviation A11B, 707-320B Aircraft

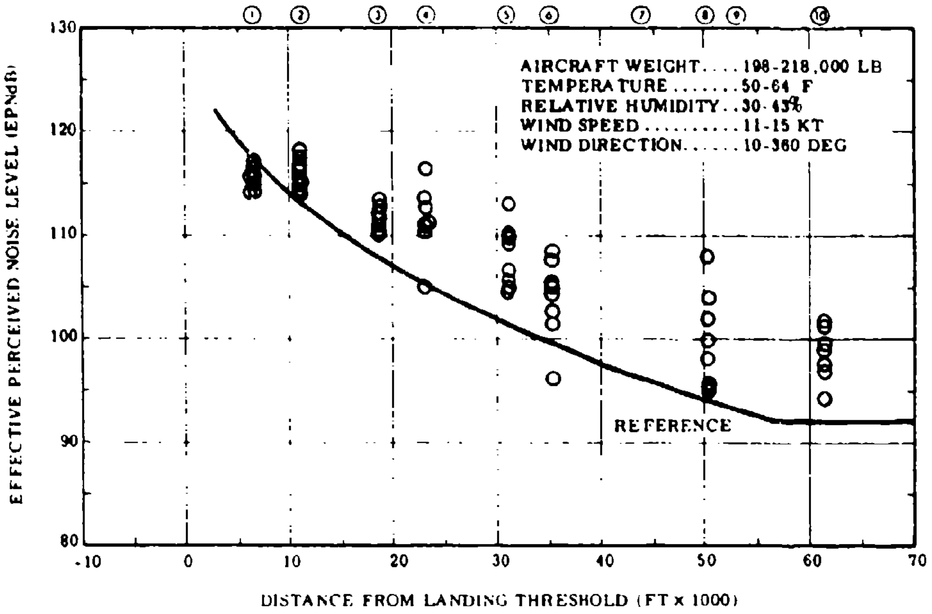

Figure C-37. Approach Noise Levels for Profile A21, 707-320B Aircraft

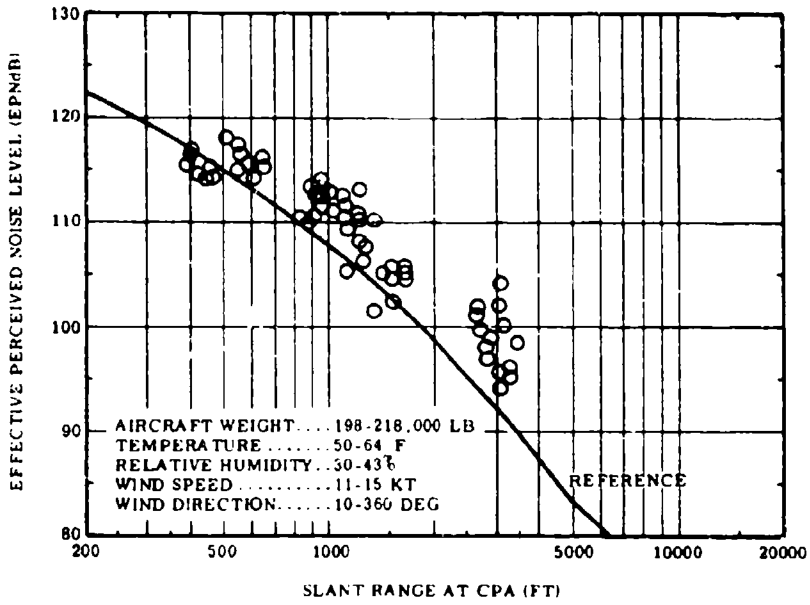

Figure C-38. Noise Levels as a Function of Slant Range for Profile A21, 707-320B Aircraft

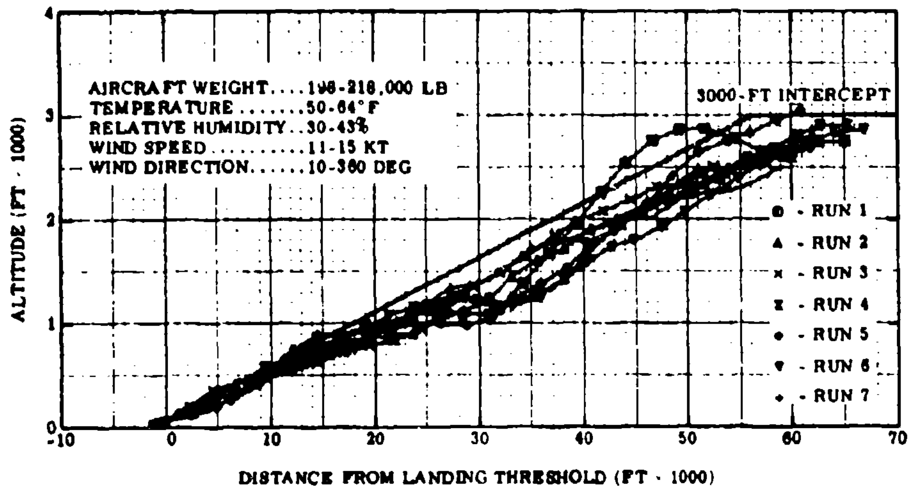

Figure C-39. Approach Profile A21, 707-320B Aircraft

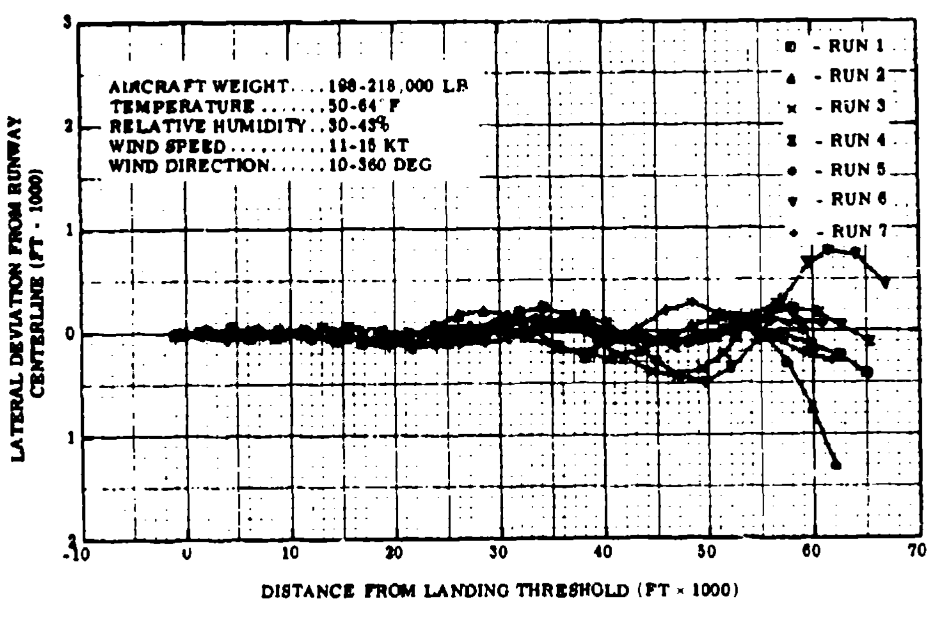

Figure C-40. Approach Lateral Deviation A21, 707-320B Aircraft

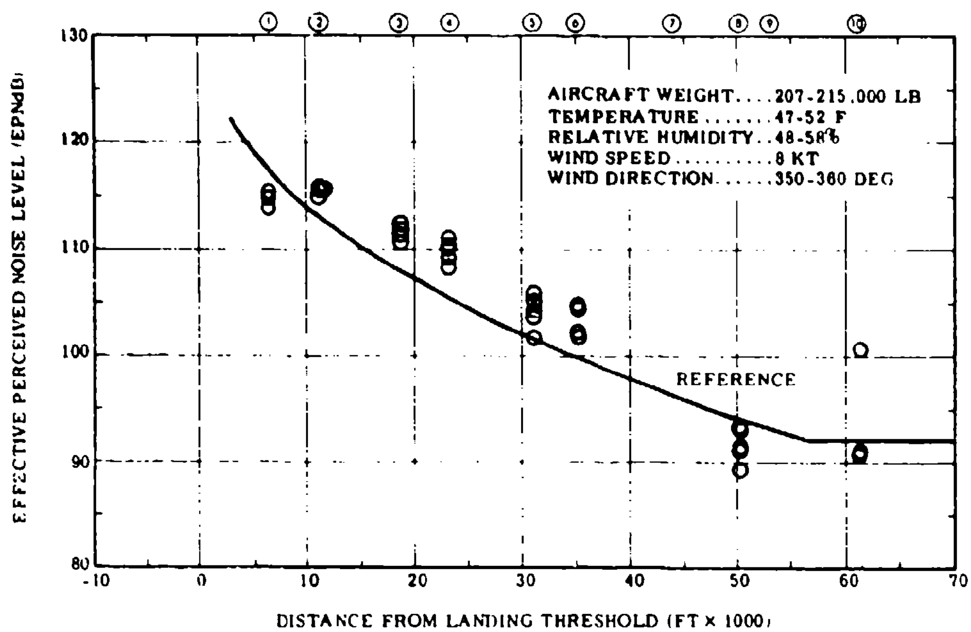

Figure C-41. Approach Noise Levels for Profile A22, 707-320B Aircraft

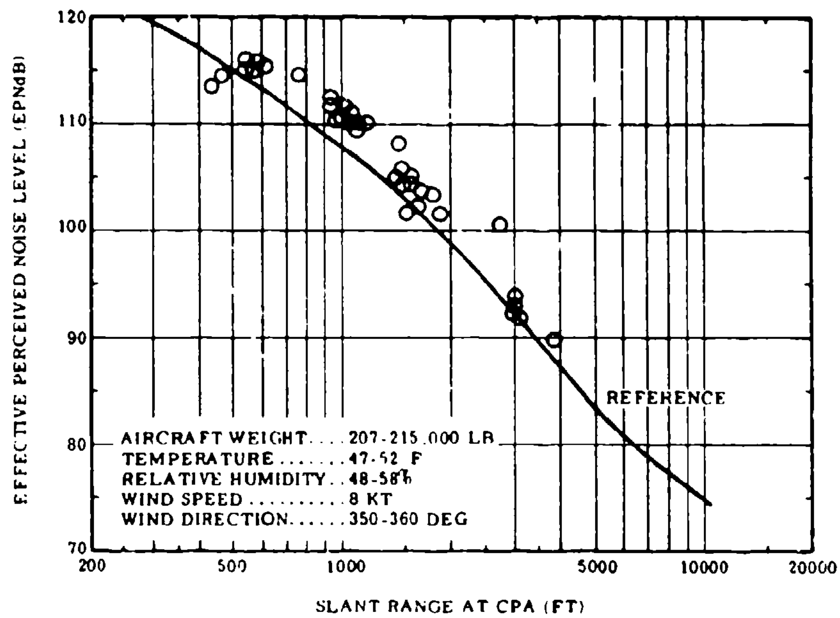

Figure C-42. Noise Levels as a Function of Slant Range for Profile A22, 707-320B Aircraft

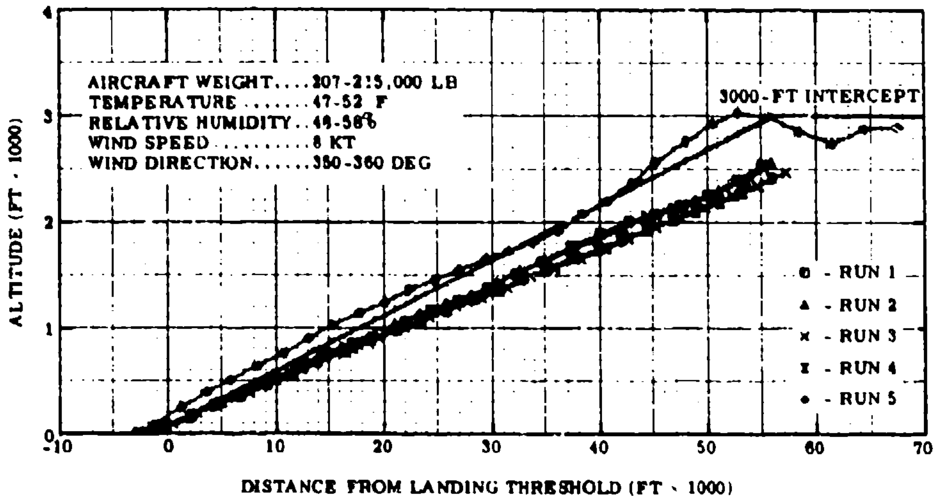

Figure C-43. Approach Profile A22, 707-320B Aircraft

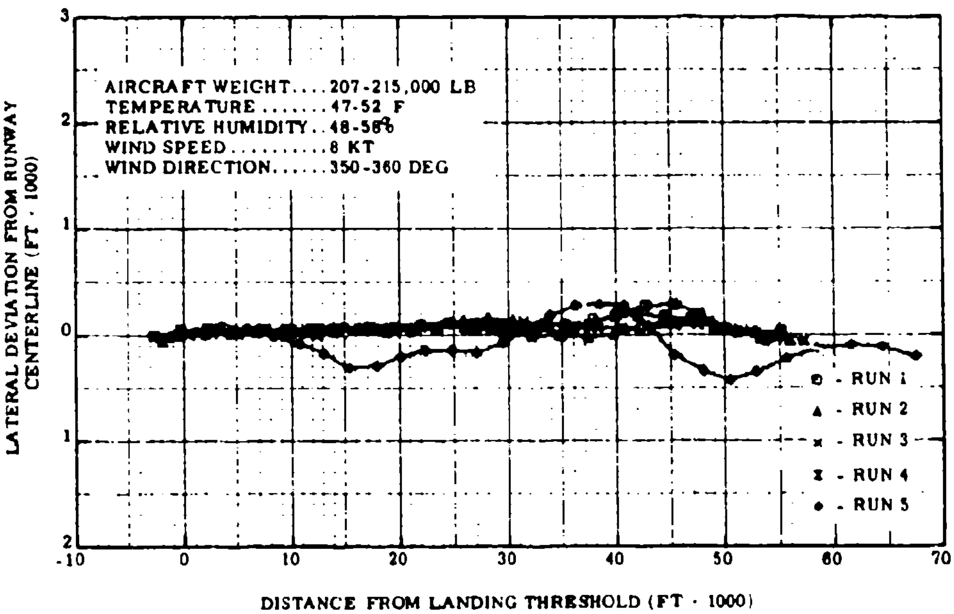

Figure C-44. Approach Lateral Deviation A22, 707-320B Aircraft

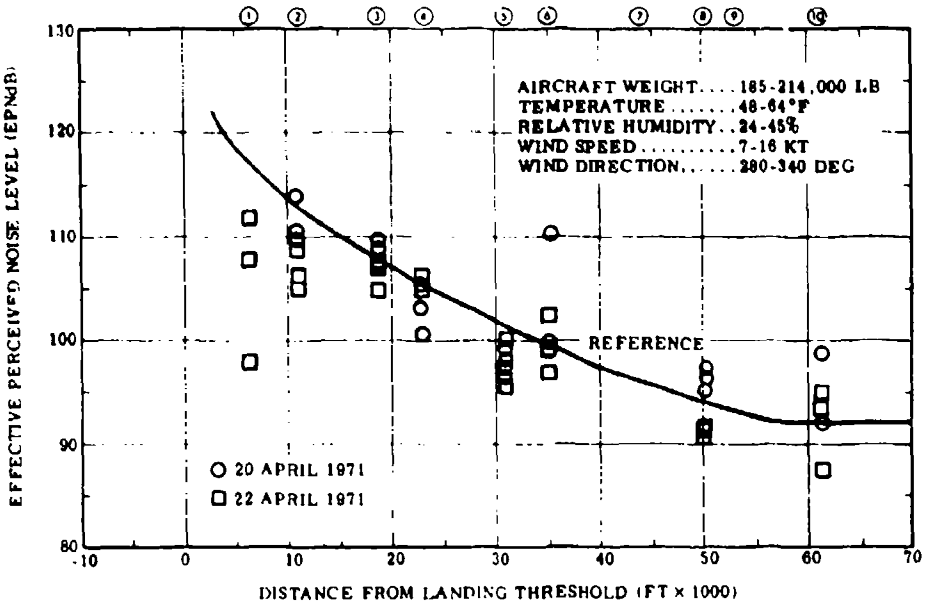

Figure C-45. Approach Noise Levels for Profile A23, 707-320B Aircraft

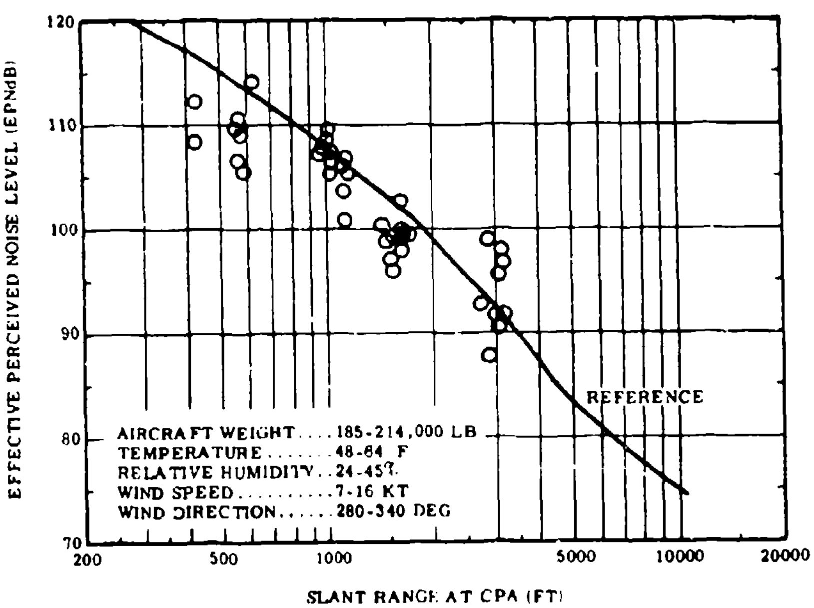

Figure C-46. Noise Levels as a Function of Slant Range for Profile A23, 707-320B Aircraft

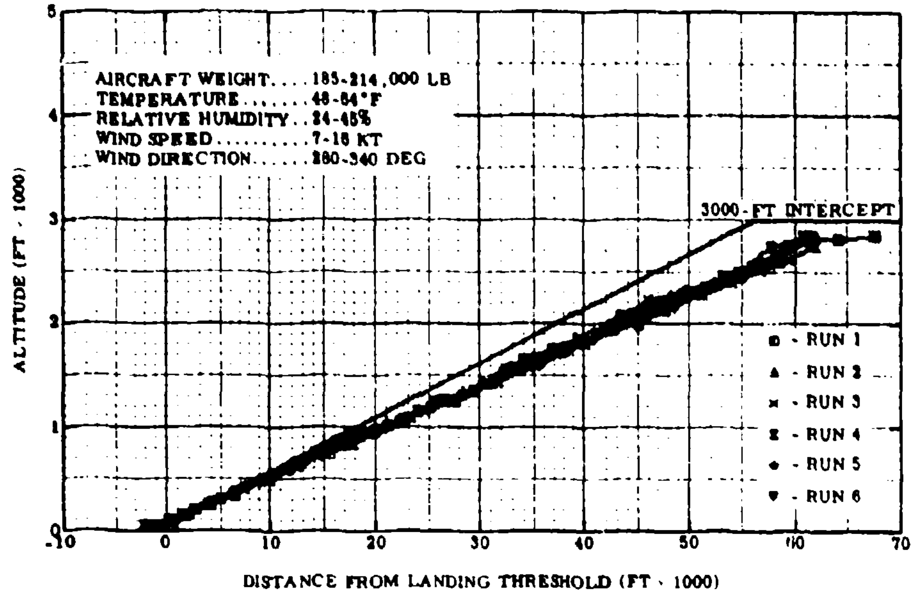

Figure C-47. Approach Profile A23, 707-320B Aircraft

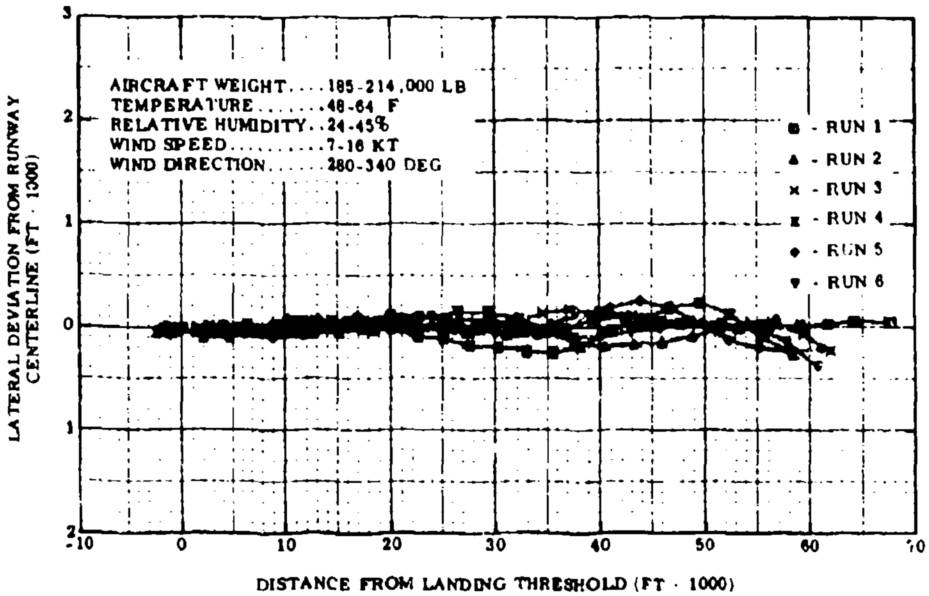

Figure C-48. Approach Lateral Deviation A23, 707-320B Aircraft

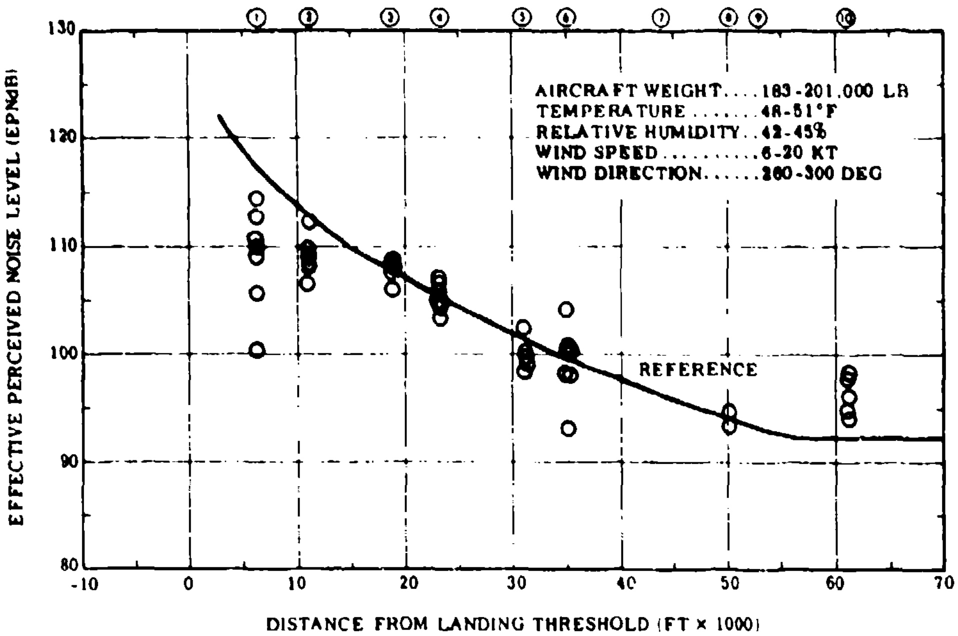

Figure C-49. Approach Noise Levels for Profile A31, 707-320B Aircraft

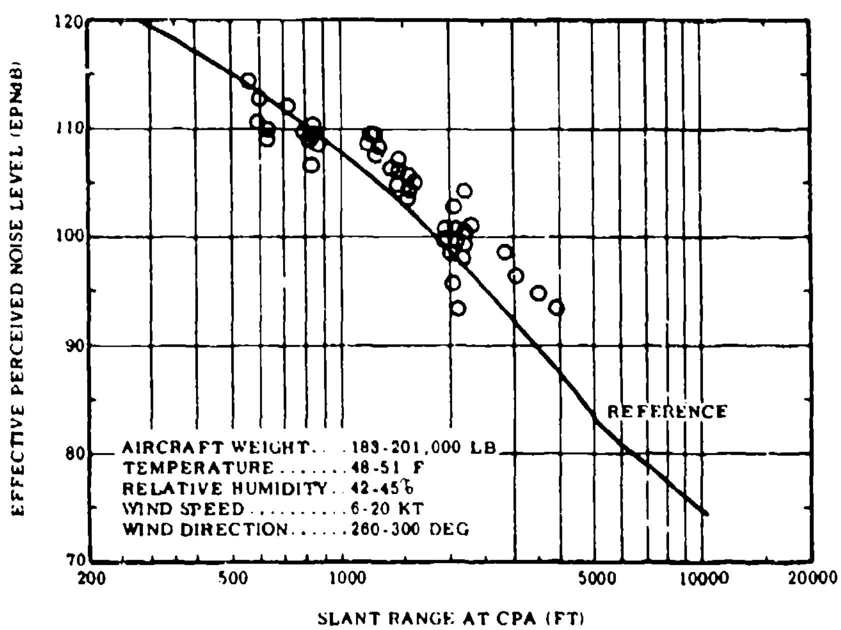

Figure C-50. Noise Levels as a Function of Slant Range for Profile A31, 707-320B Aircraft

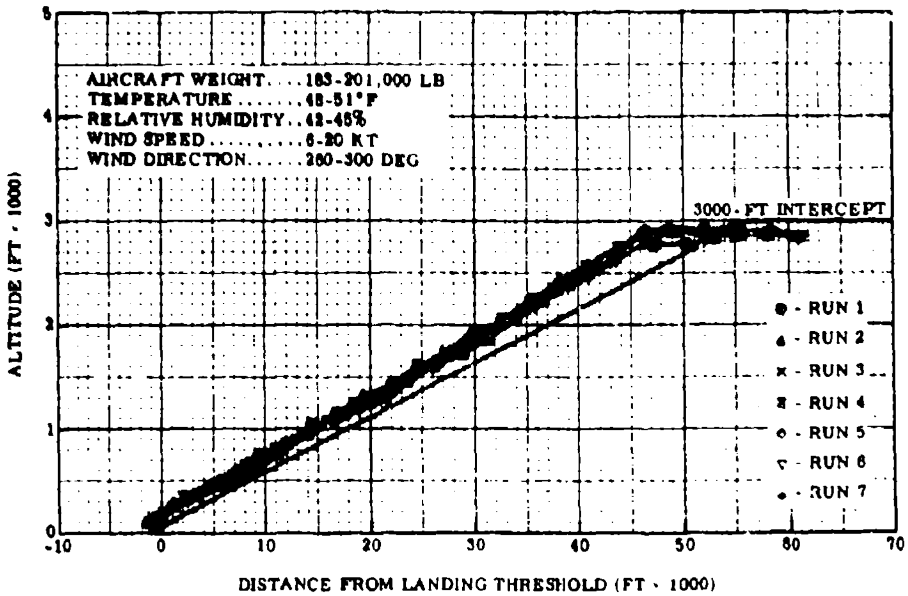

Figure C-51. Approach Profile A31, 707-320B Aircraft

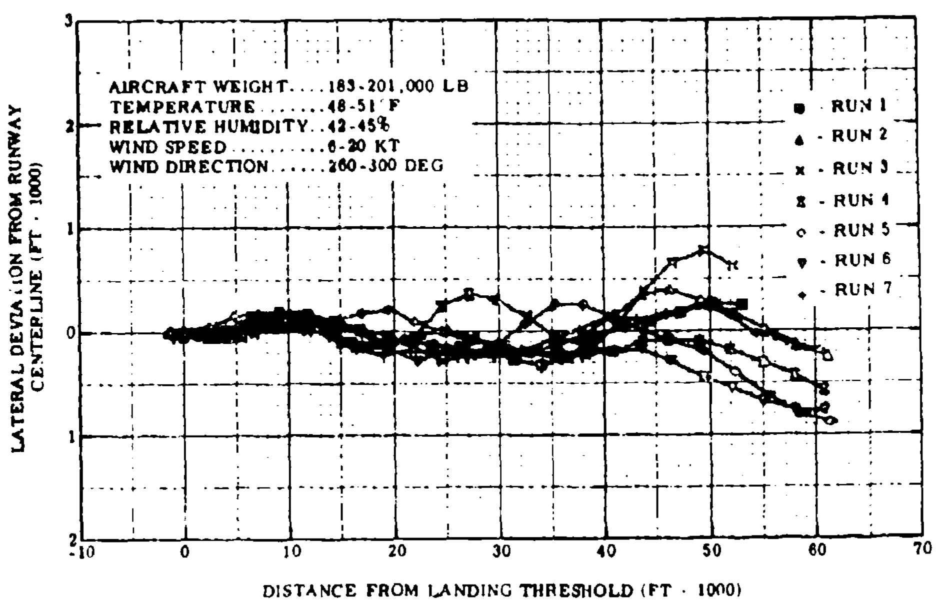

Figure C-52. Approach Lateral Deviation A31, 707-320B Aircraft

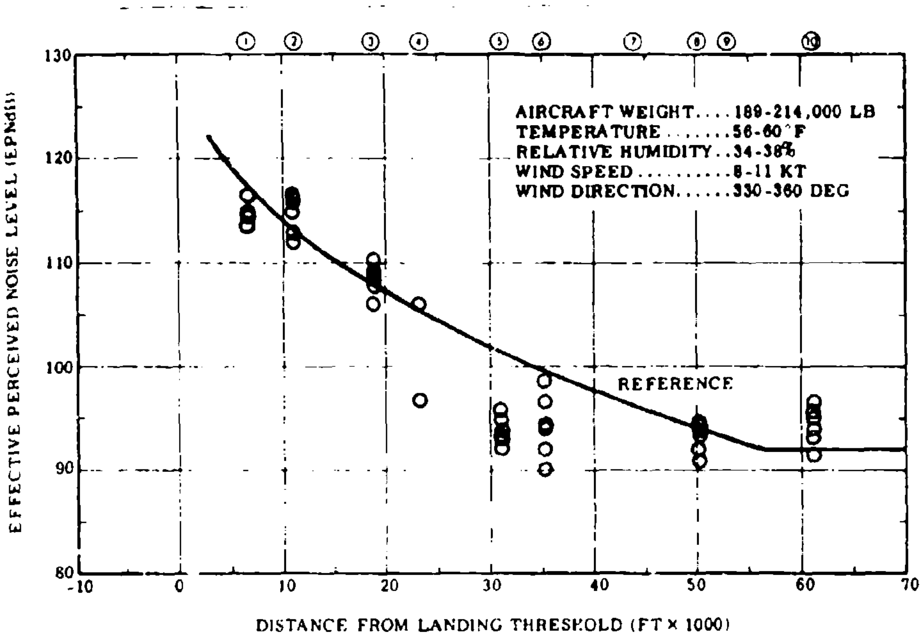

Figure C-53. Approach Noise Levels for Profile A41, 707-320B Aircraft

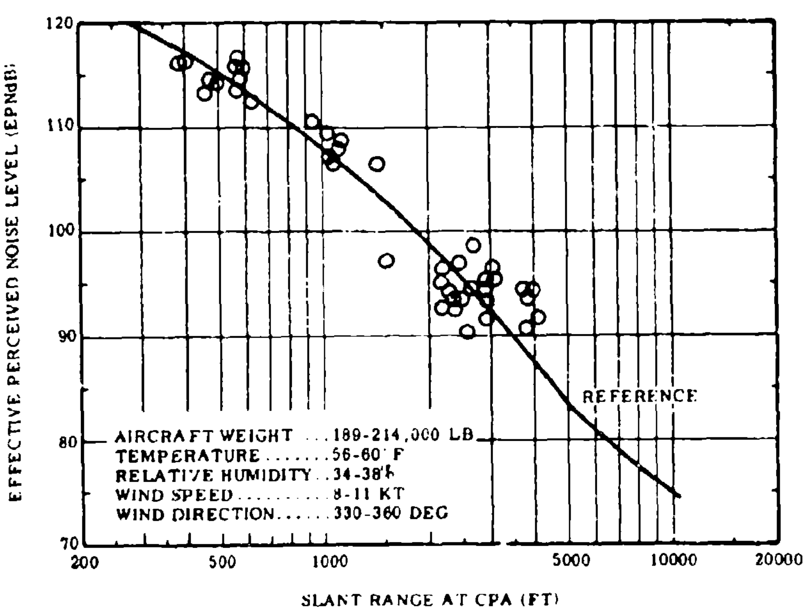

Figure C-54. Noise Levels as a Function of Slant Range for Profile A41, 707-320B Aircraft

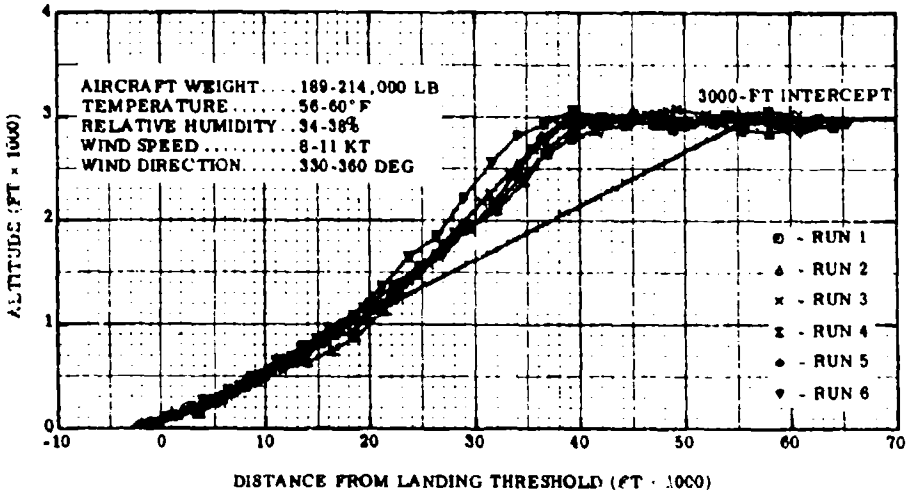

Figure C-55. Approach Profile A41, 707-320B Aircraft

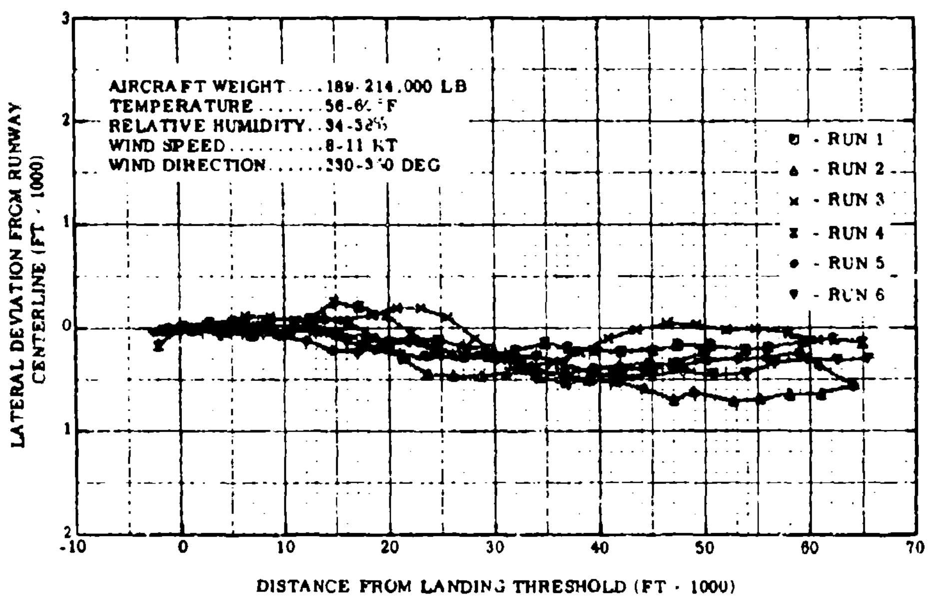

Figure C-56. Approach Lateral Deviation A41, 707-320B Aircraft

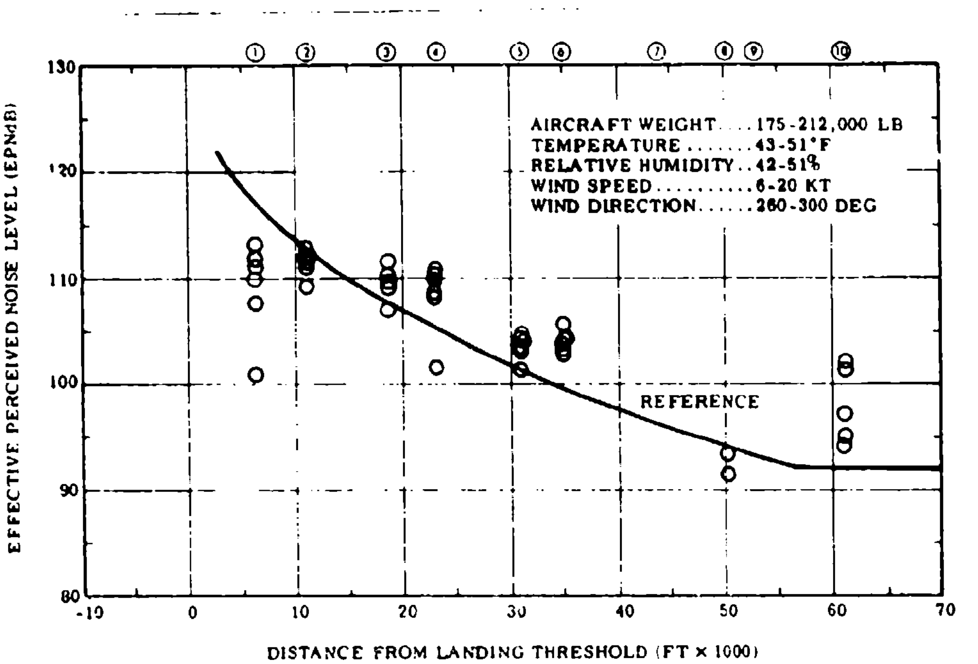

Figure C-57. Approach Noise Levels for Profile A51, 707-320B Aircraft

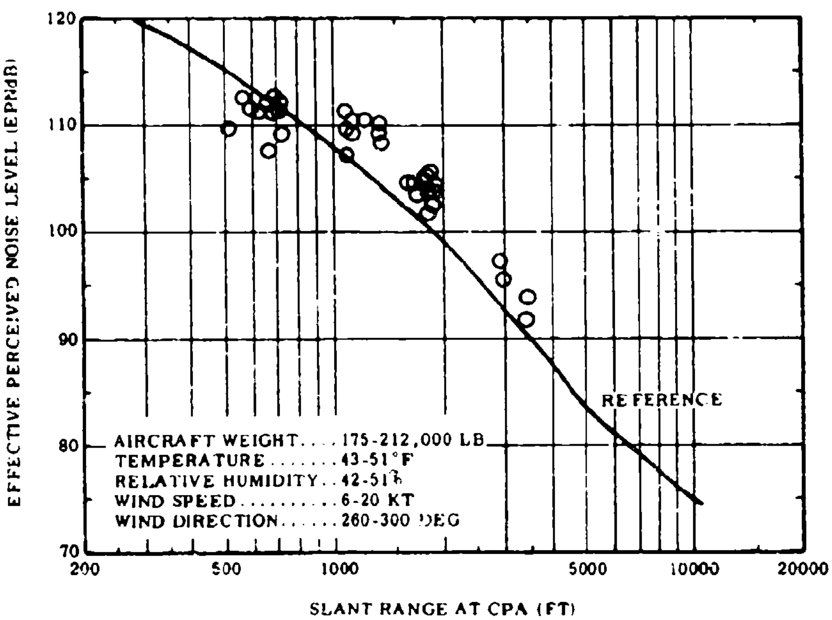

Figure C-58. Noise Levels as a Function of Slant Range for Profile A51, 707-320B Aircraft

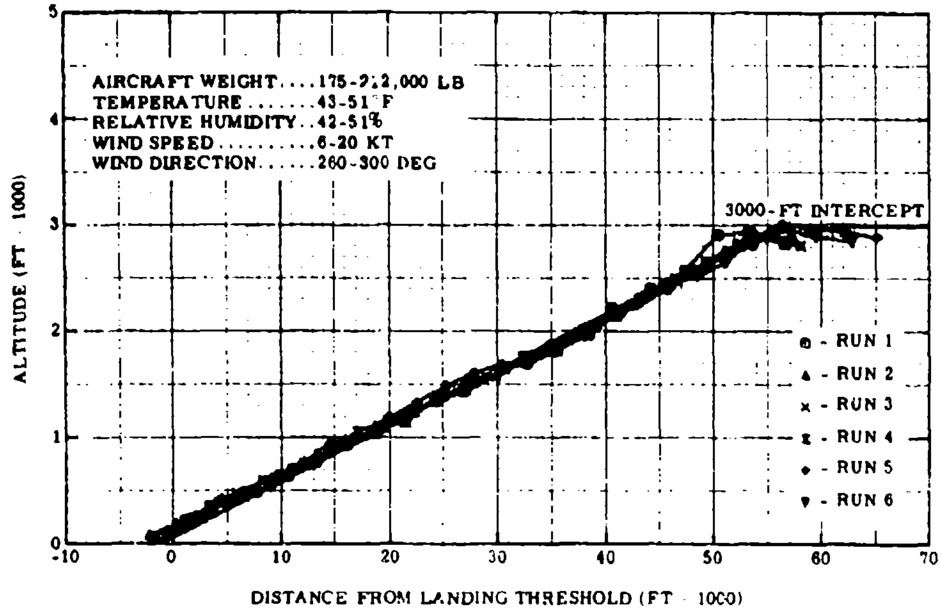

Figure C-59. Approach Profile A51, 707-320B Aircraft

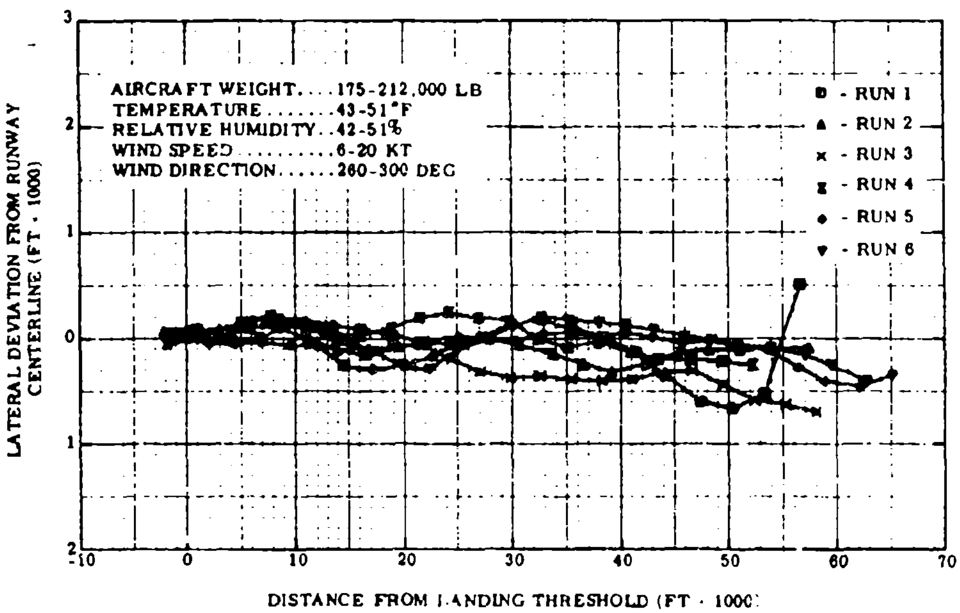

Figure C-60. Approach Lateral Deviation A51, 707-320B Aircraft

Appendix D

DC-9 AIRCRAFT
DETAILED NOISE AND TRACKING PLOTS

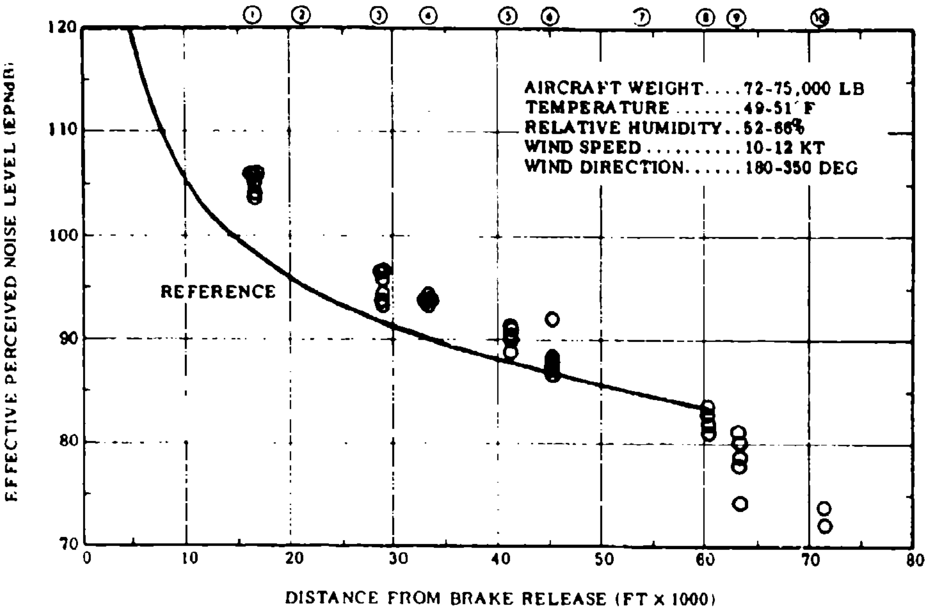

Figure D-1. Takeoff Noise Levels for Profile T1, DC-9 Aircraft

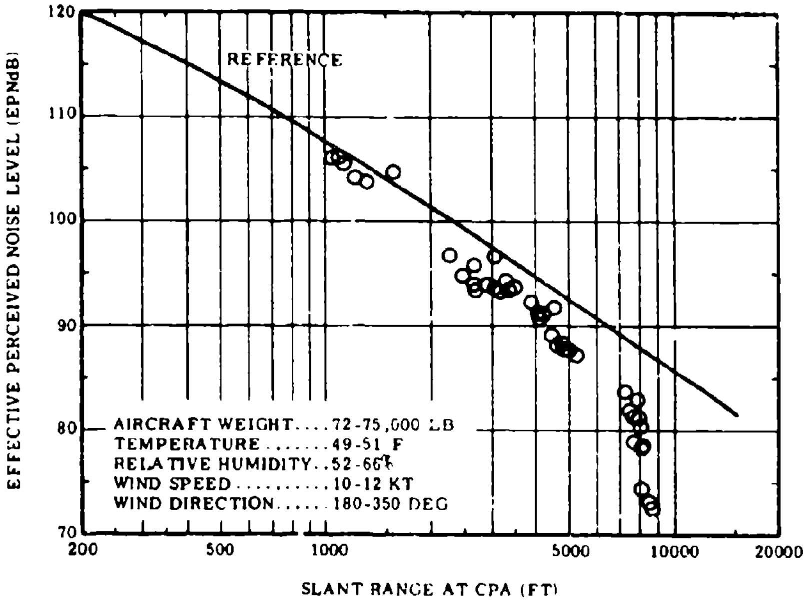

Figure D-2. Noise Levels as a Function of Slant Range for Profile T1, DC-9 Aircraft

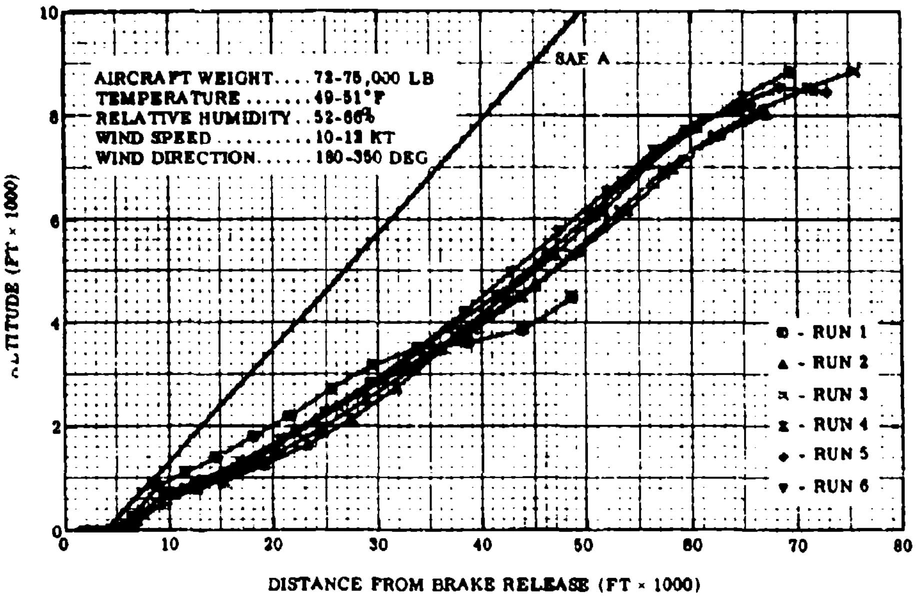

Figure D-3. Takeoff Profile T1, DC-9 Aircraft

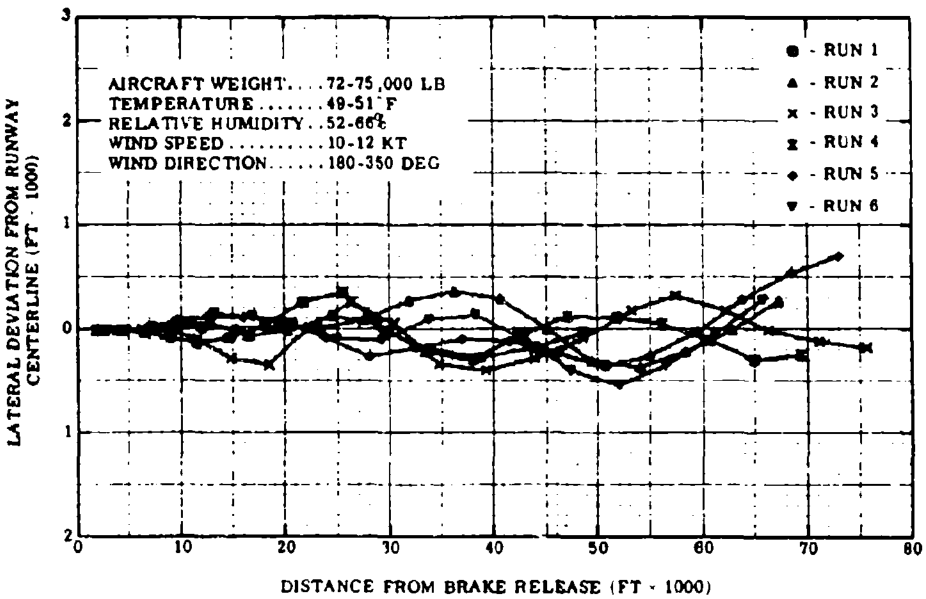

Figure D-4. Takeoff Lateral Deviation T1, DC-9 Aircraft

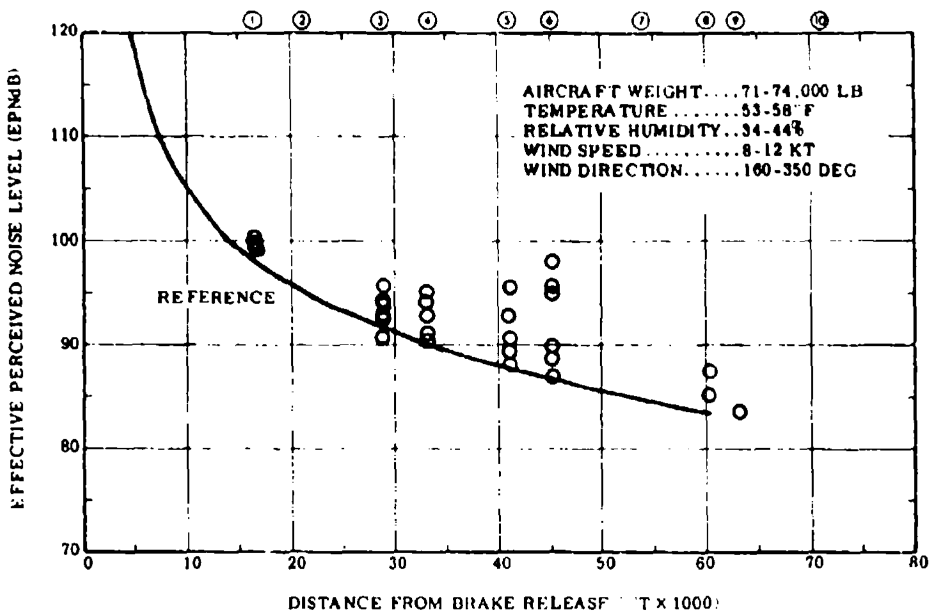

Figure D-5. Takeoff Noise Levels for Profile T2, DC-9 Aircraft

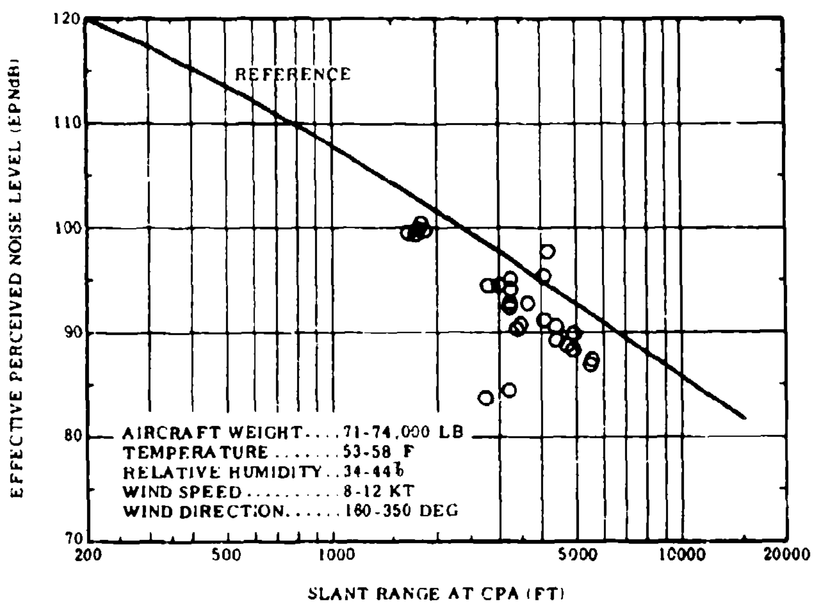

Figure D-6. Noise Levels as a Function of Slant Range for Profile T2, DC-9 Aircraft

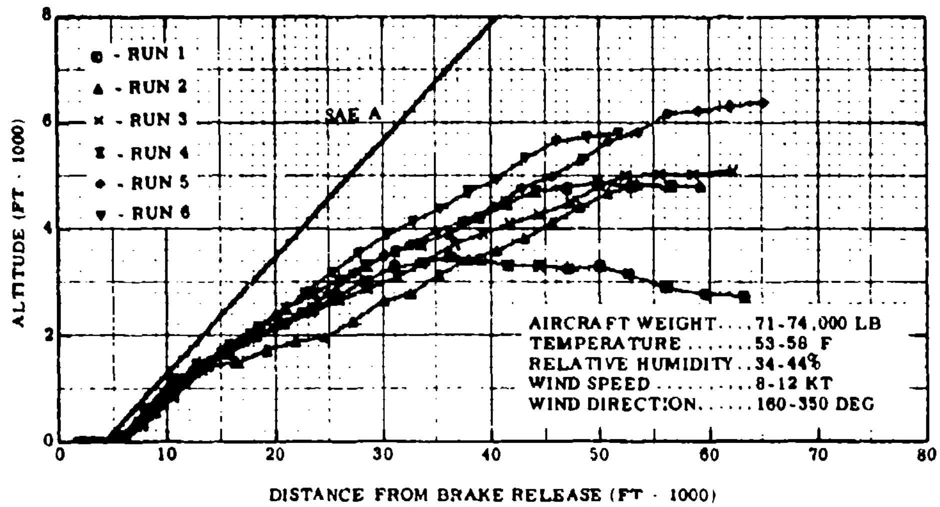

Figure D-7. Takeoff Profile T2, DC-9 Aircraft

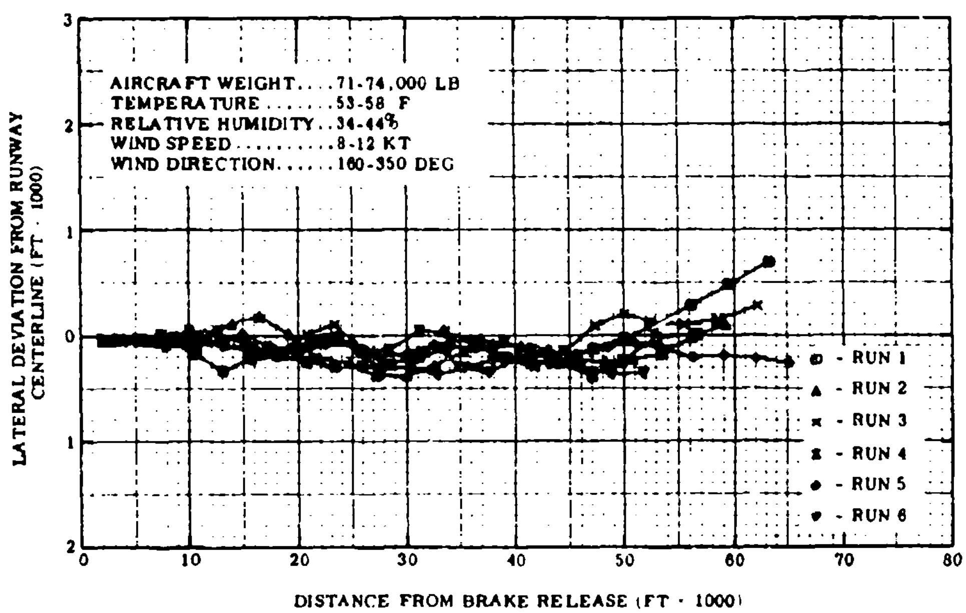

Figure D-8. Takeoff Lateral Deviation T2, DC-9 Aircraft

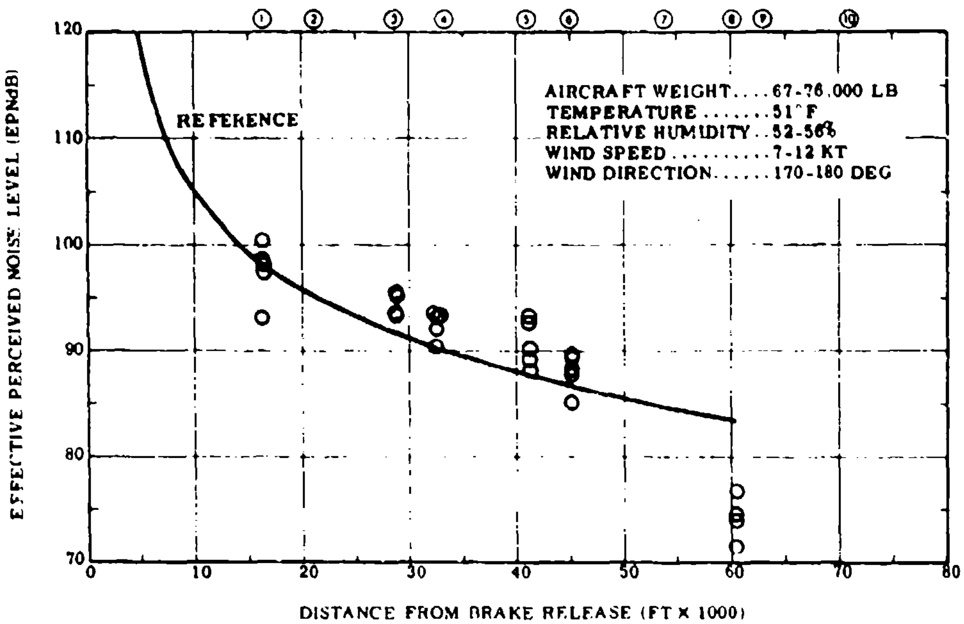

Figure D-9. Takeoff Noise Levels for Profile T3, DC-9 Aircraft

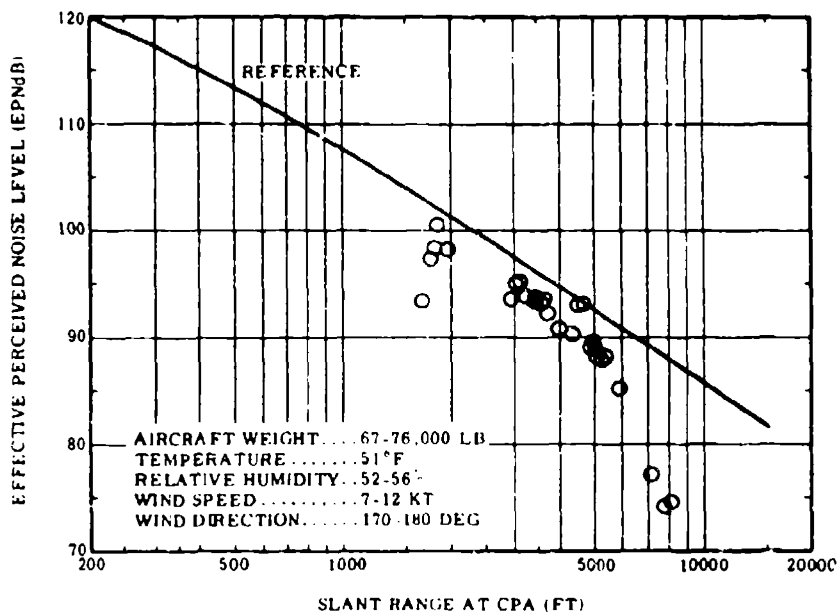

Figure D-10. Noise Levels as a Function of Slant Range for Profile T3, DC-9 Aircraft

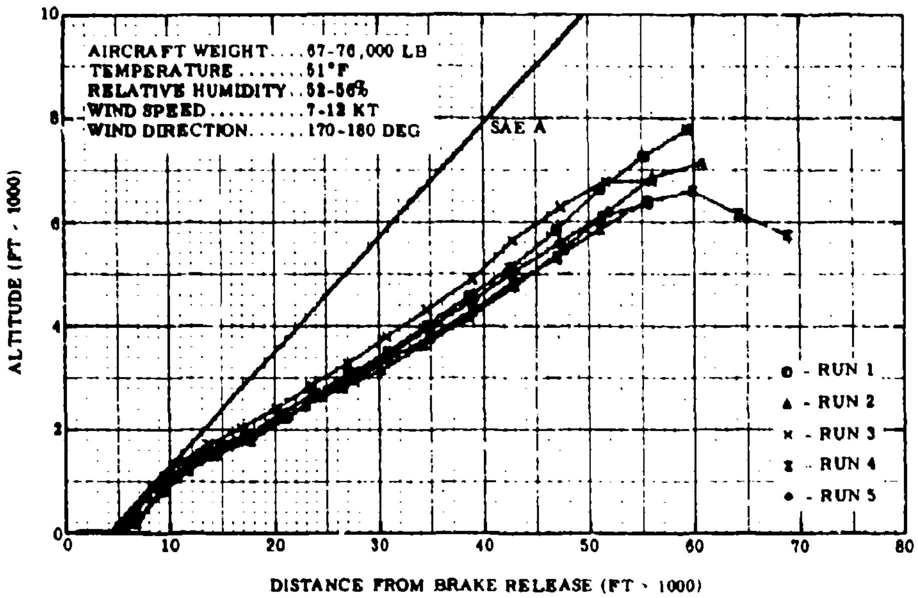

Figure D-11. Takeoff Profile T3, DC-9 Aircraft

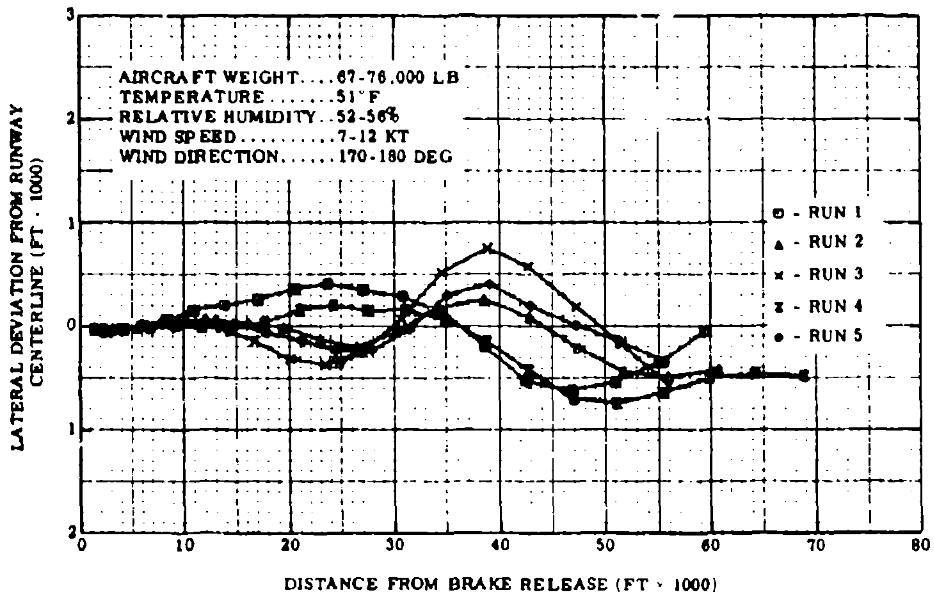

Figure D-12. Takeoff Lateral Deviation T3, DC-9 Aircraft

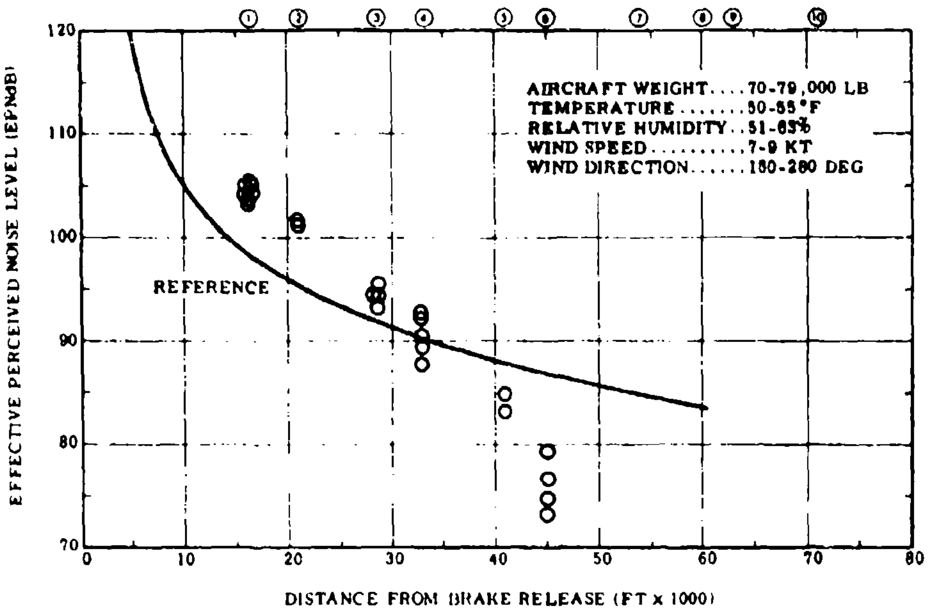

Figure D-13. Takeoff Noise Levels for Profile T4, DC-9 Aircraft

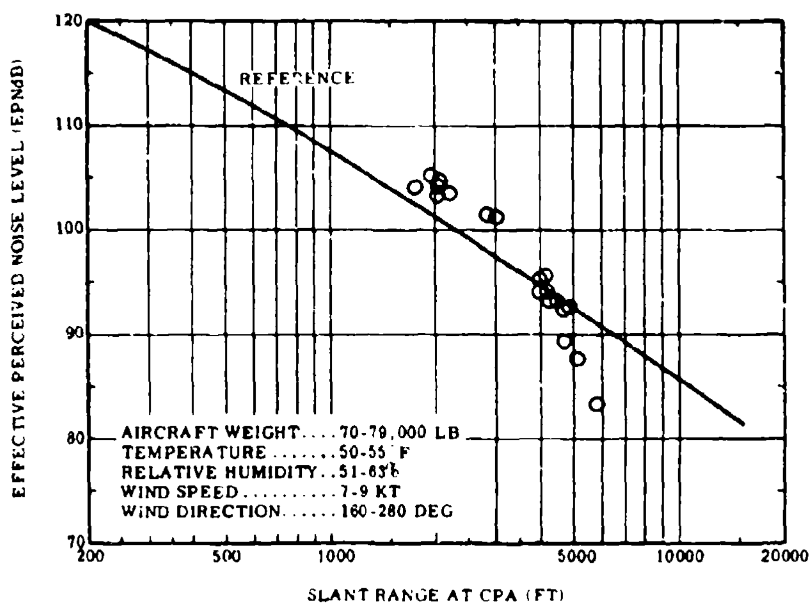

Figure D-14. Noise Levels as a Function of Slant Range for Profile T4, DC-9 Aircraft

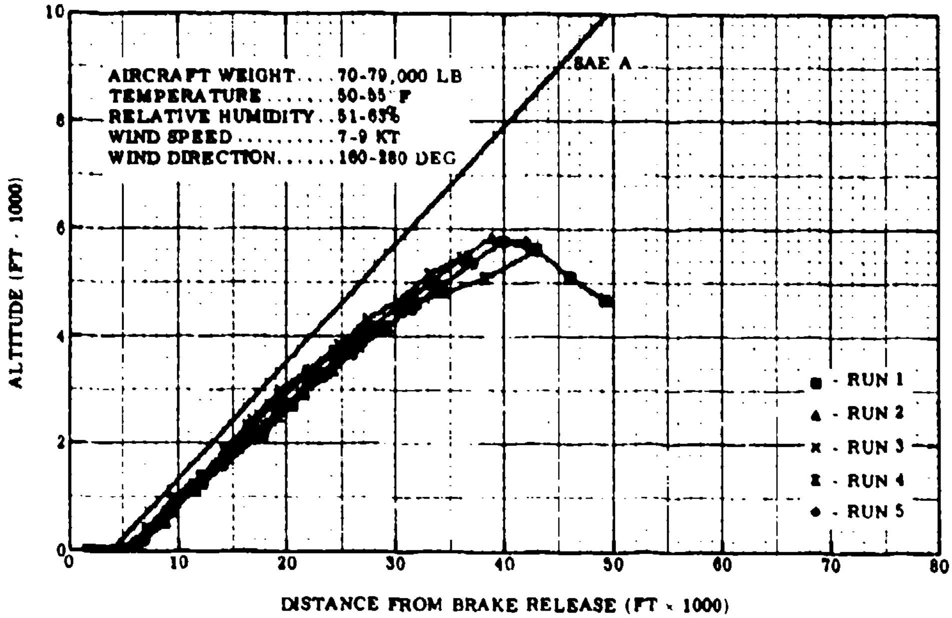

Figure D-15. Takeoff Profile T4, DC-9 Aircraft

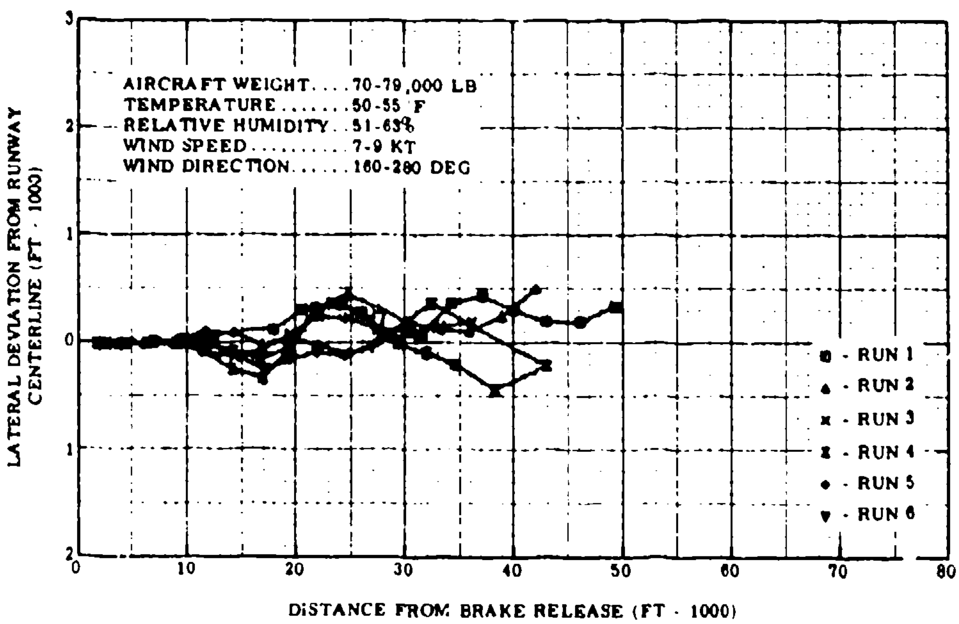

Figure D-16. Takeoff Lateral Deviation T4, DC-9 Aircraft

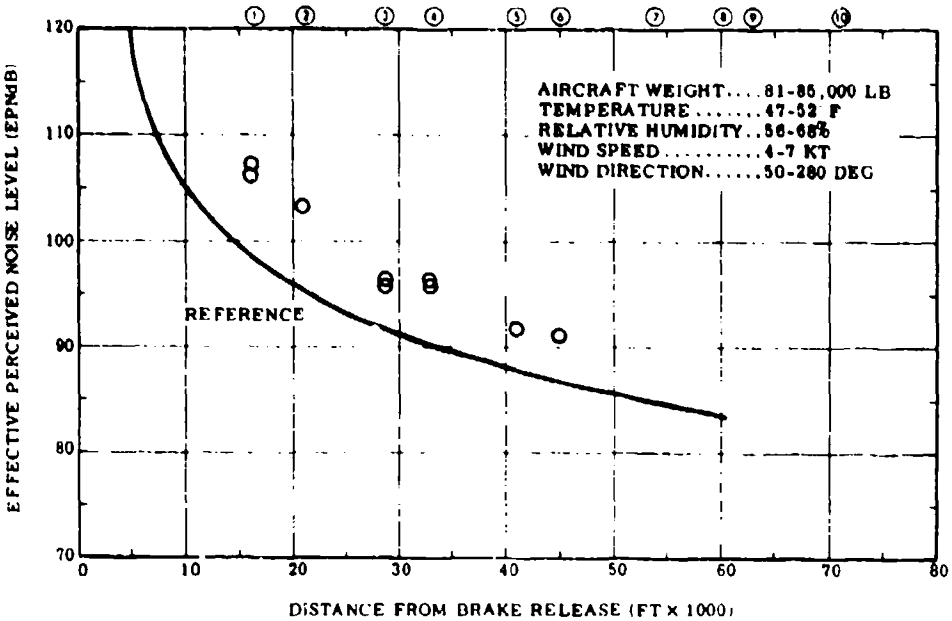

Figure D-17. Takeoff Noise Levels for Profile T5, DC-9 Aircraft

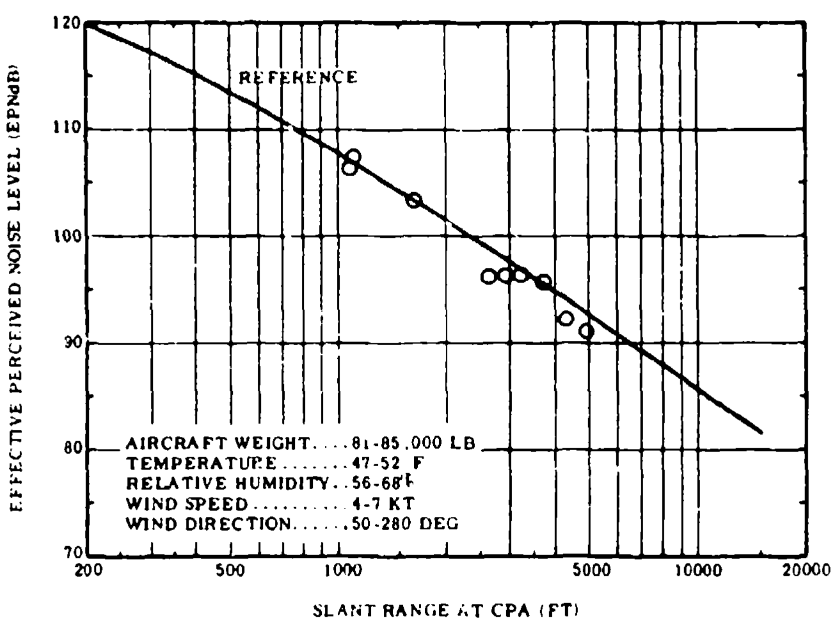

Figure D-18. Noise Levels as a Function of Slant Range for Profile T5, DC-9 Aircraft

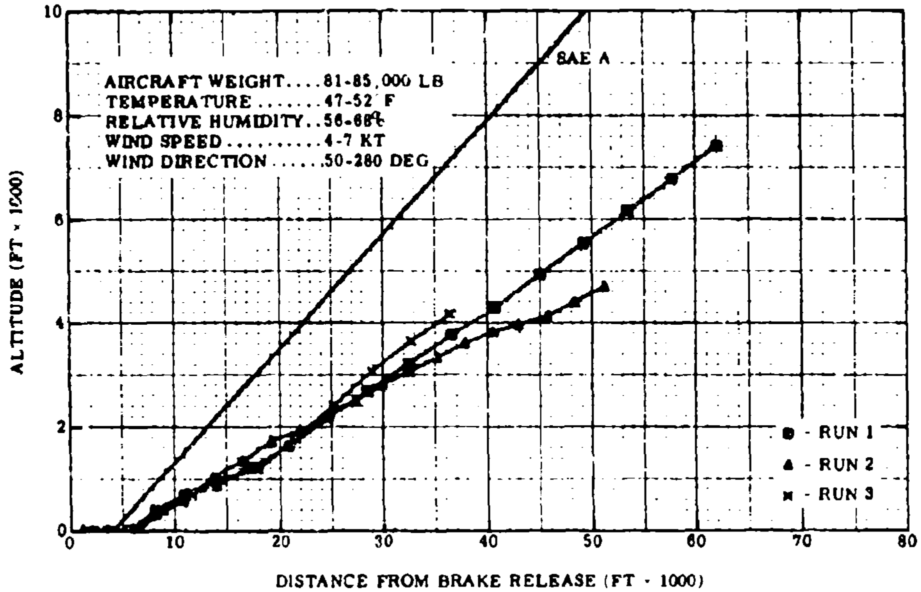

Figure D-19. Takeoff Profile T5, DC-9 Aircraft

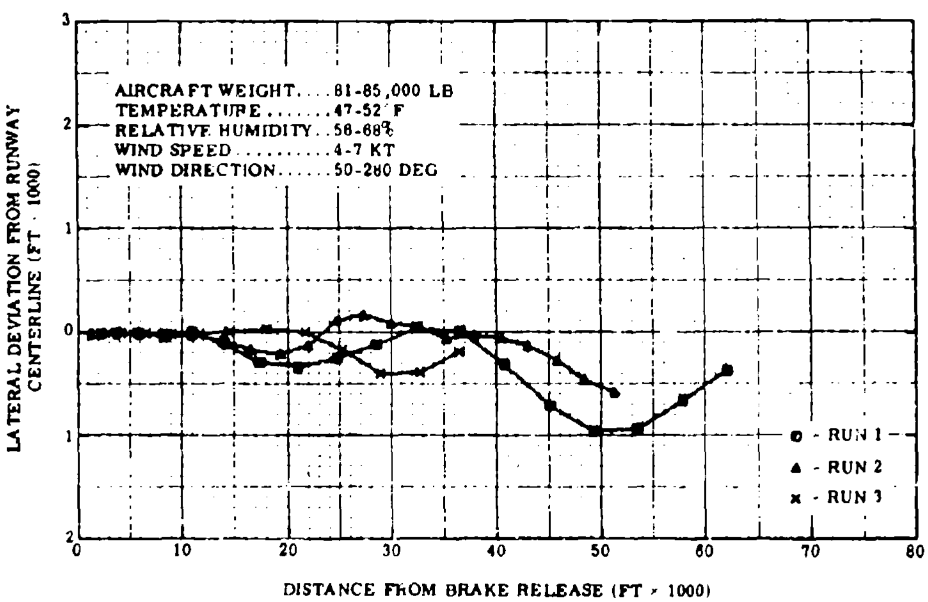

Figure D-20. Takeoff Lateral Deviation T5, DC-9 Aircraft

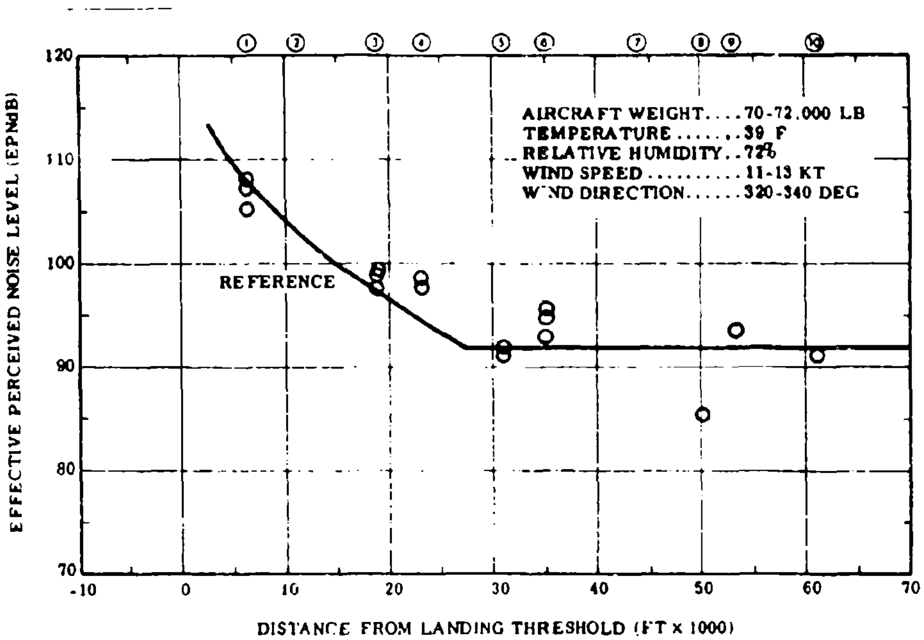

Figure D-21. Approach Noise Levels for Profile A11A, DC-9 Aircraft

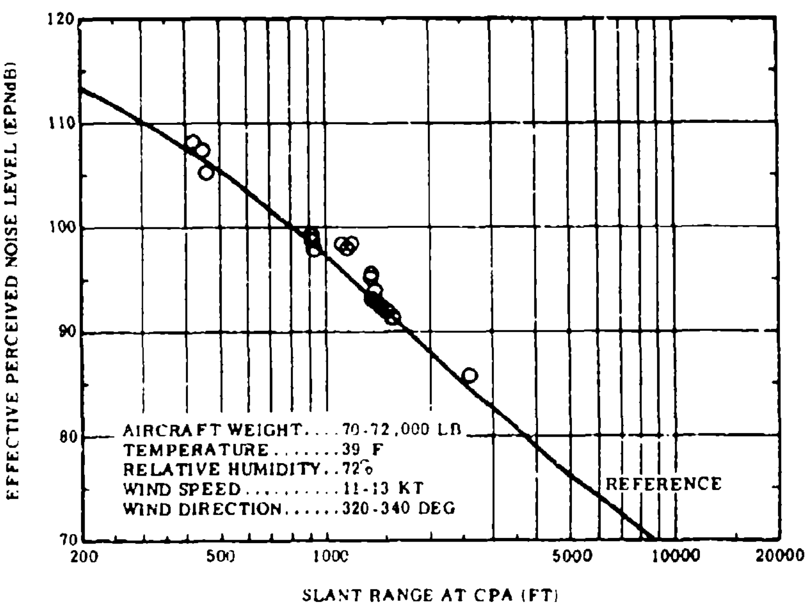

Figure D-22. Noise Levels as a Function of Slant Range for Profile A11A, DC-9 Aircraft

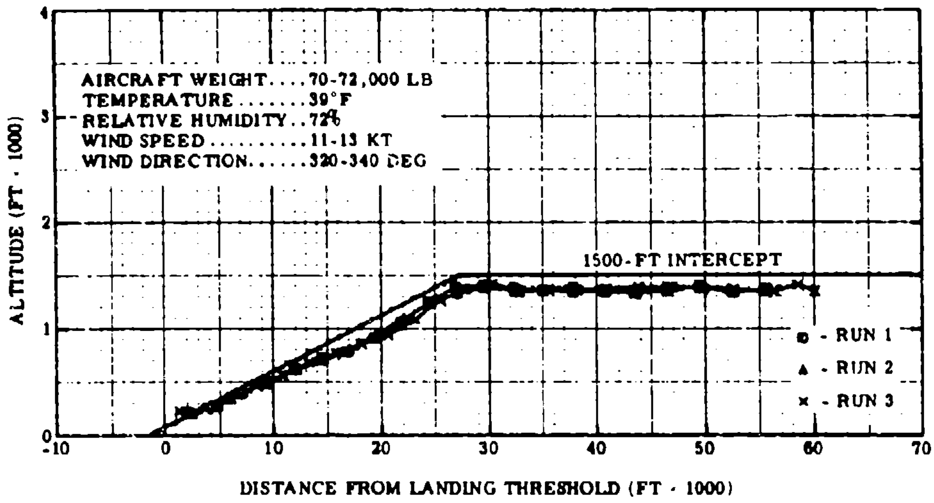

Figure D-23. Approach Profile A11A, DC-9 Aircraft

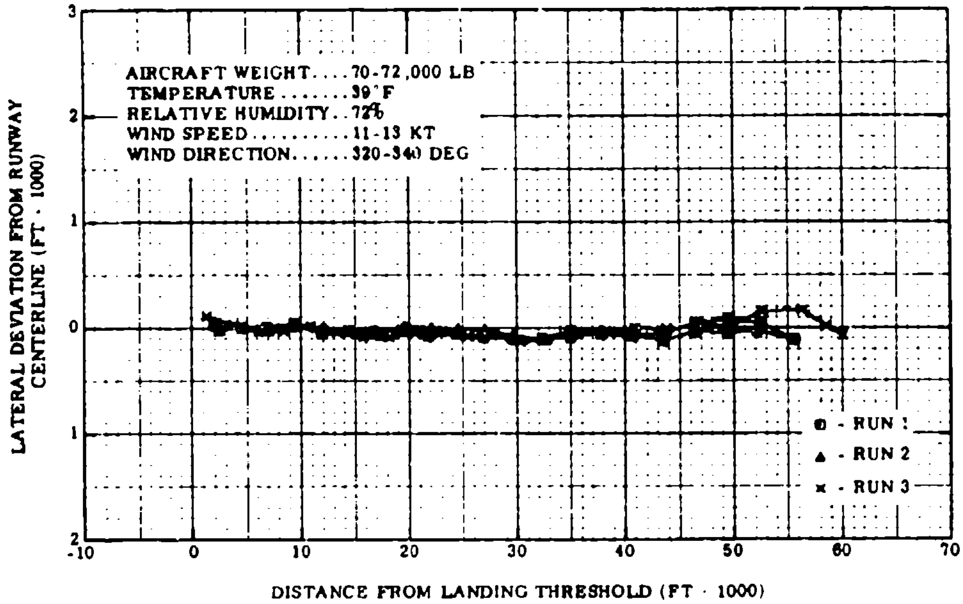

Figure D-24. Approach Lateral Deviation A11A, DC-9 Aircraft

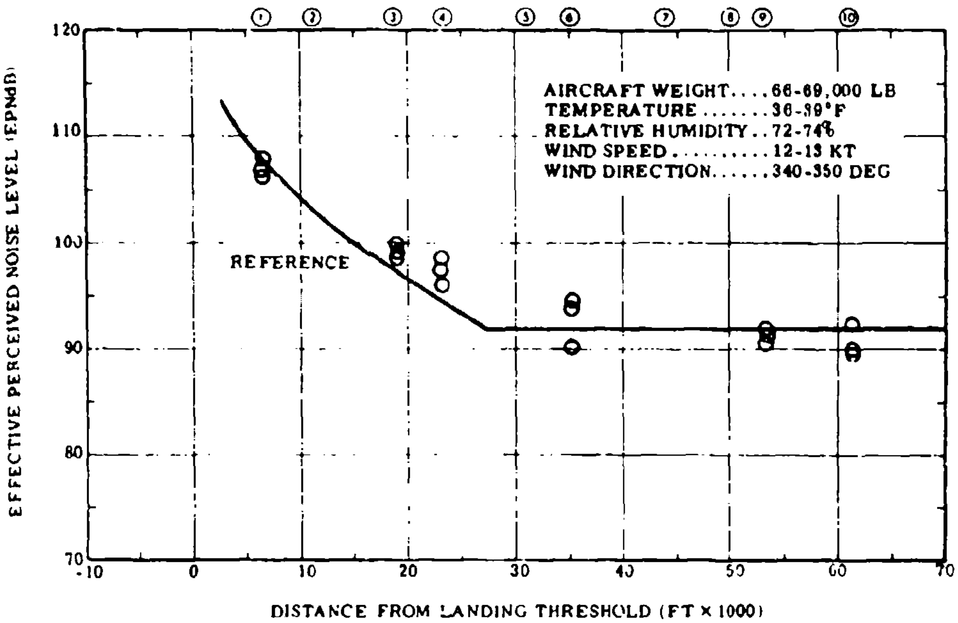

Figure D-25. Approach Noise Levels for Profile A11B, DC-9 Aircraft

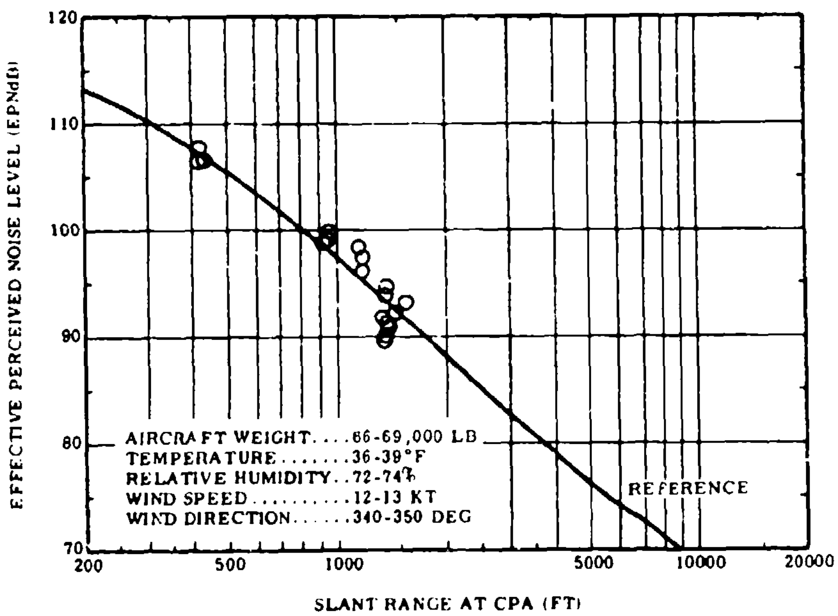

Figure D-26. Noise Levels as a Function of Slant Range for Profile A11B, DC-9 Aircraft

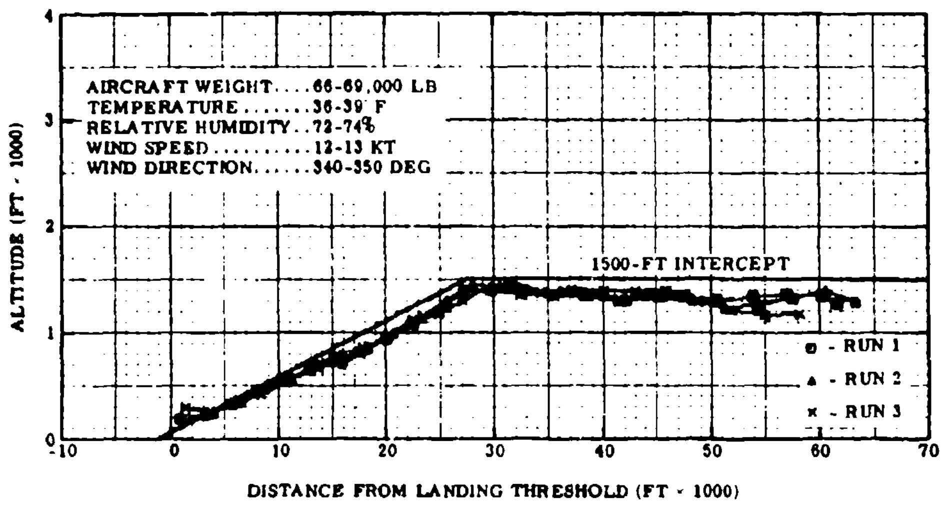

Figure D-27. Approach Profile A11B, DC-9 Aircraft

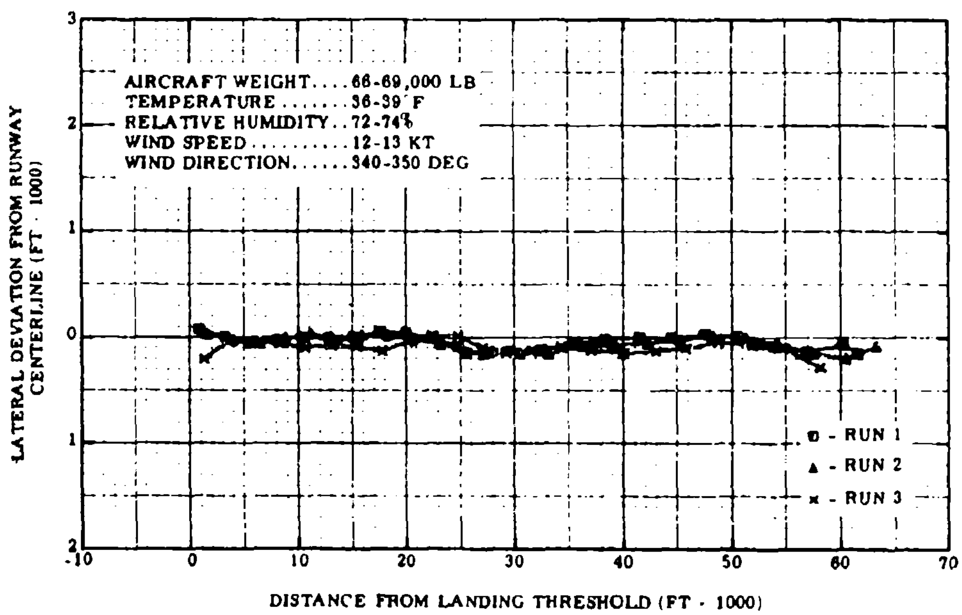

Figure D-28. Approach Lateral Deviation A11B, DC-9 Aircraft

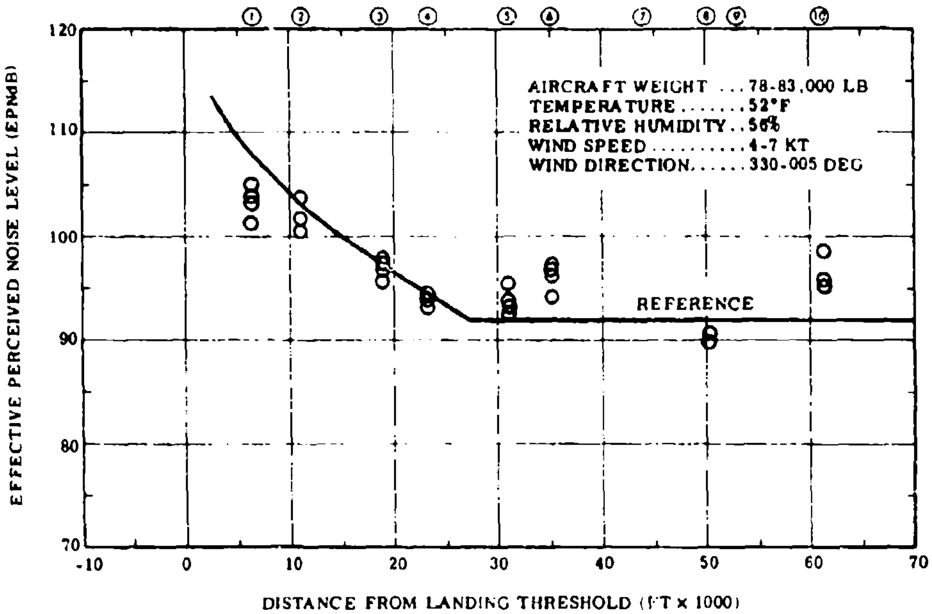

Figure D-29. Approach Noise Levels for Profile A12, DC-9 Aircraft

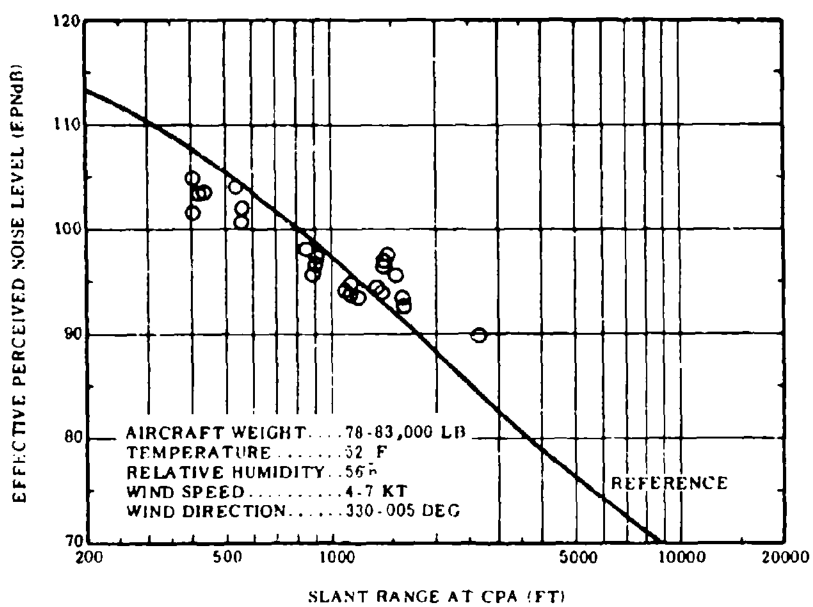

Figure D-30. Noise Levels as a Function of Slant Range for Profile A12, DC-9 Aircraft

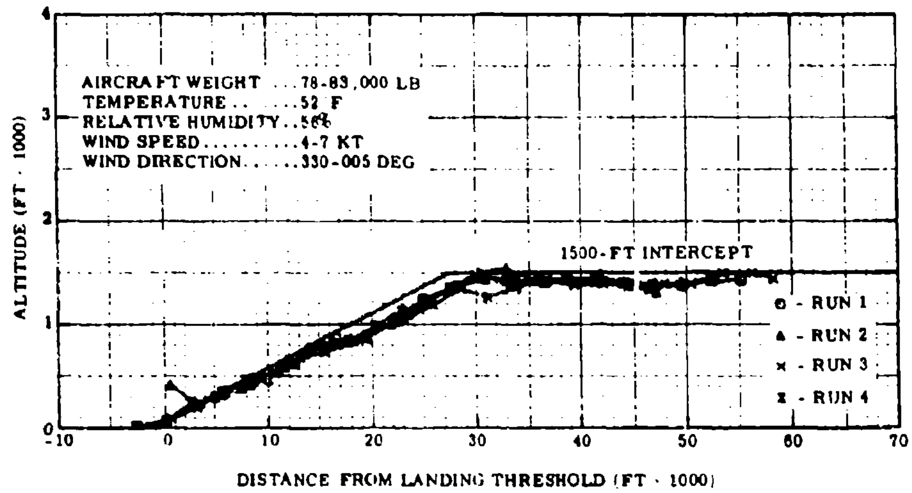

Figure D-31. Approach Profile A12, DC-9 Aircraft

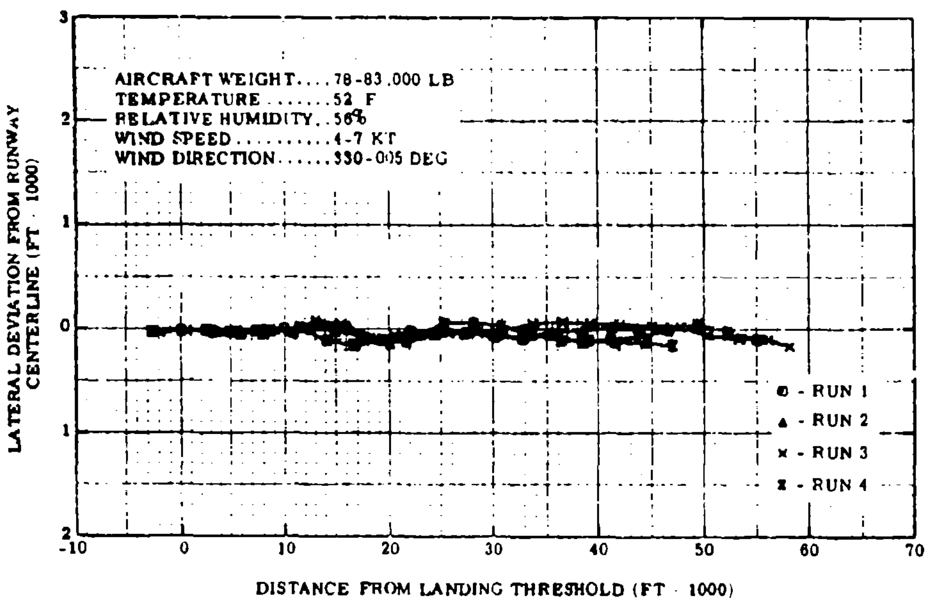

Figure D-32. Approach Lateral Deviation A12, DC-9 Aircraft

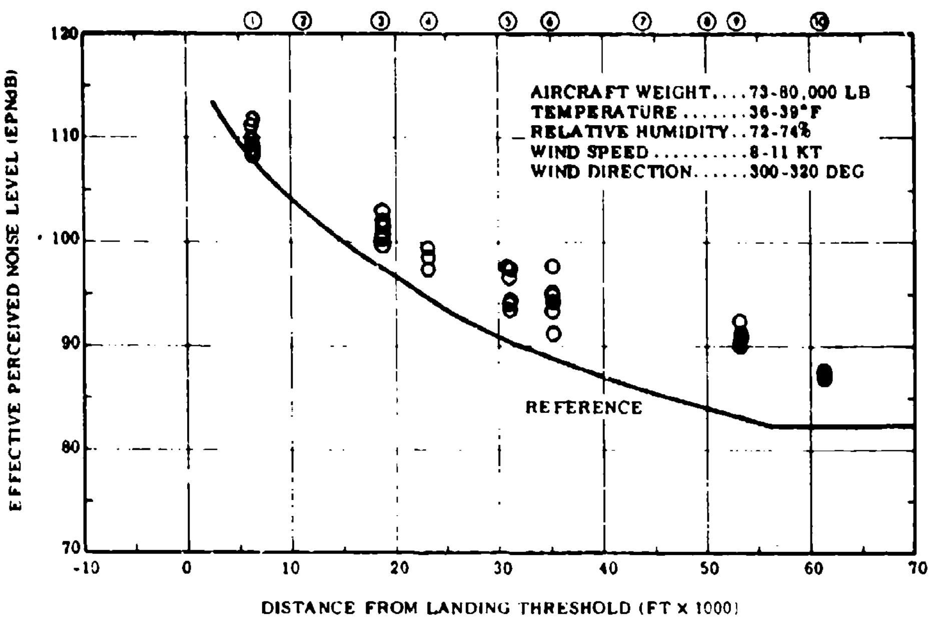

Figure D-33. Approach Noise Levels for Profile A21, DC-9 Aircraft

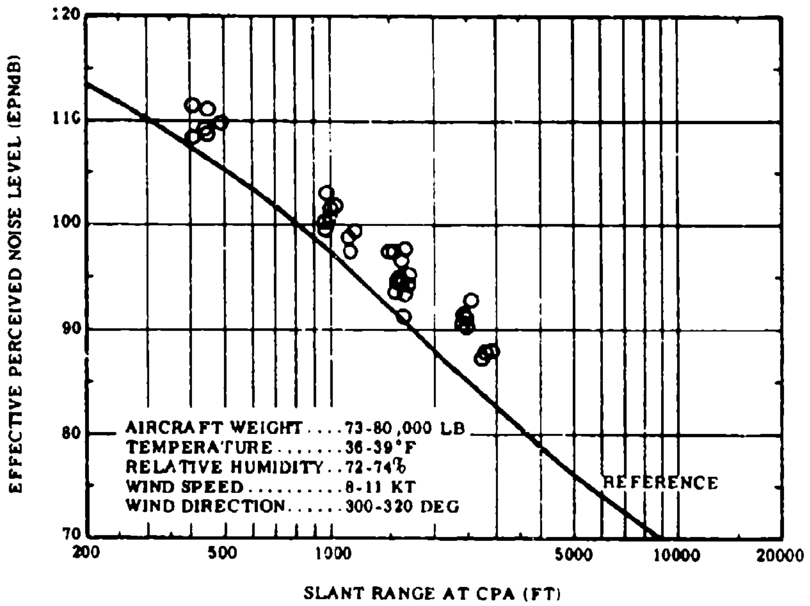

Figure D-34. Noise Levels as a Function of Slant Range for Profile A21, DC-9 Aircraft

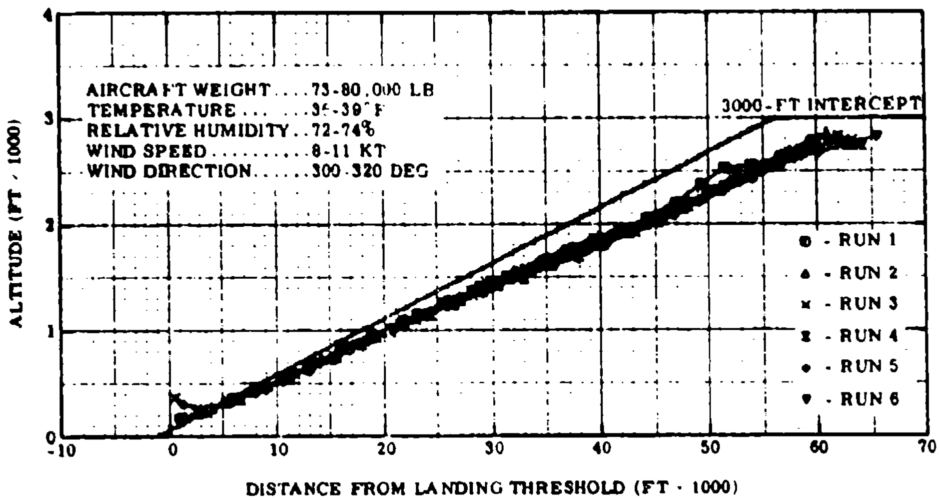

Figure D-35. Approach Profile A21, DC-9 Aircraft

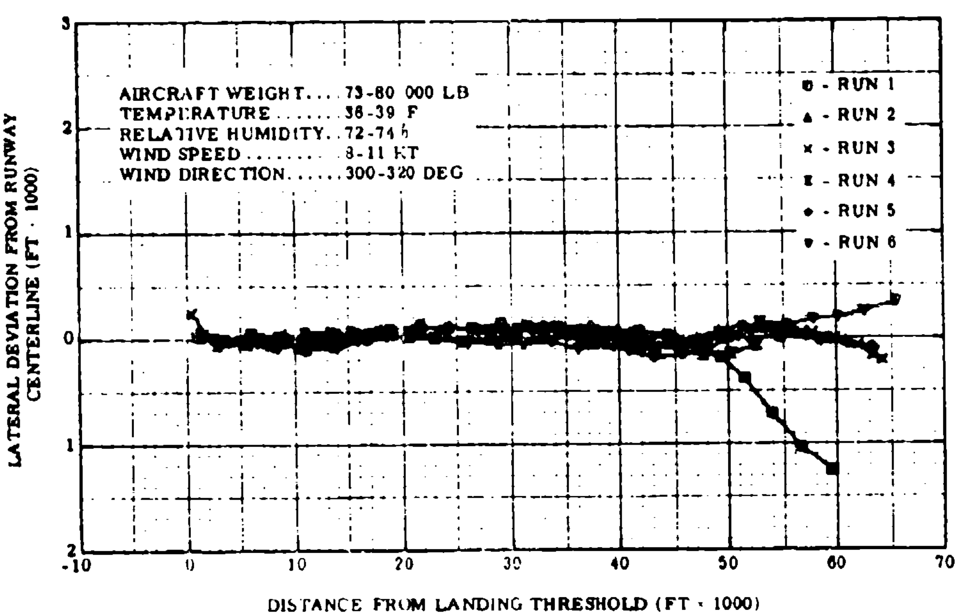

Figure D-36. Approach Lateral Deviation A21, DC-9 Aircraft

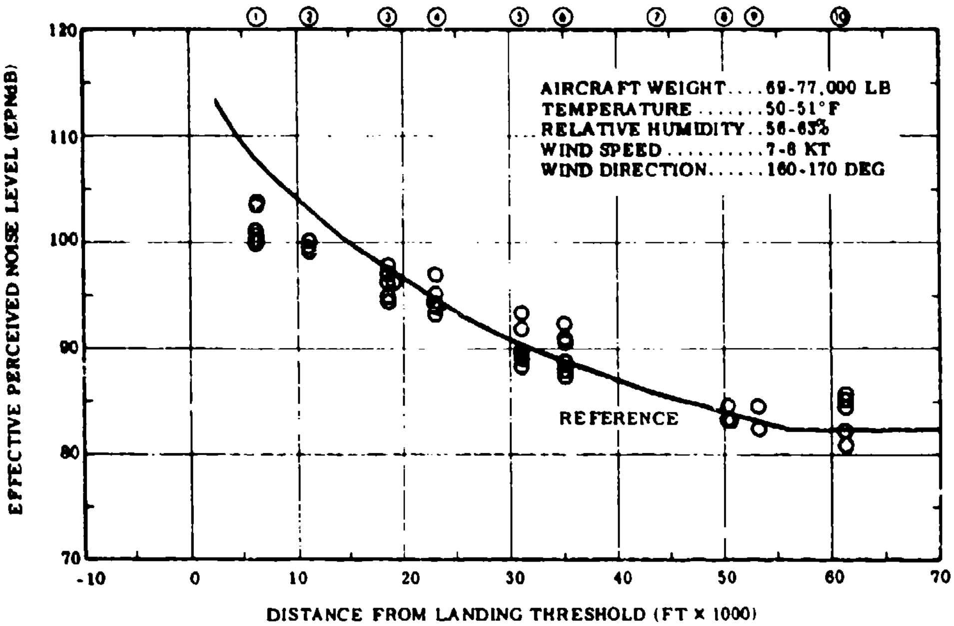

Figure D-37. Approach Noise Levels for Profile A22, DC-9 Aircraft

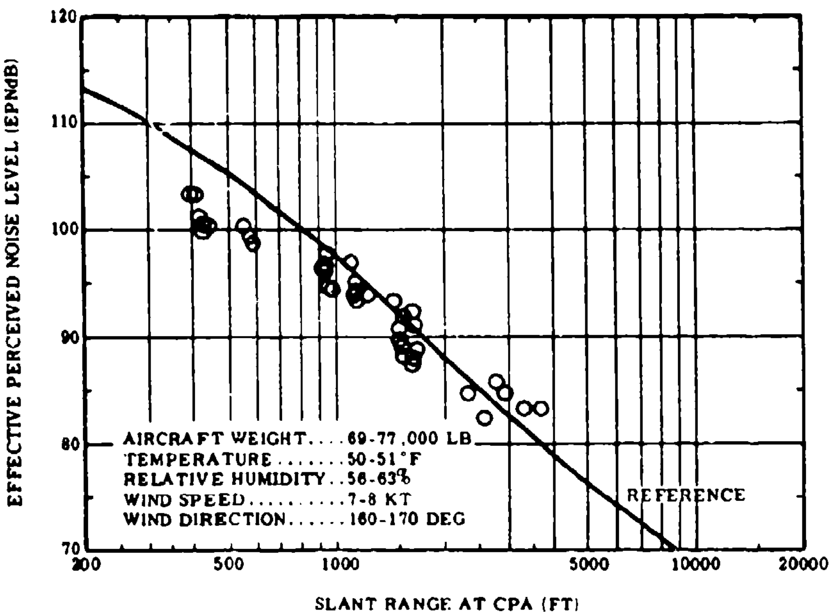

Figure D-38. Noise Levels as a Function of Slant Range for Profile A22, DC-9 Aircraft

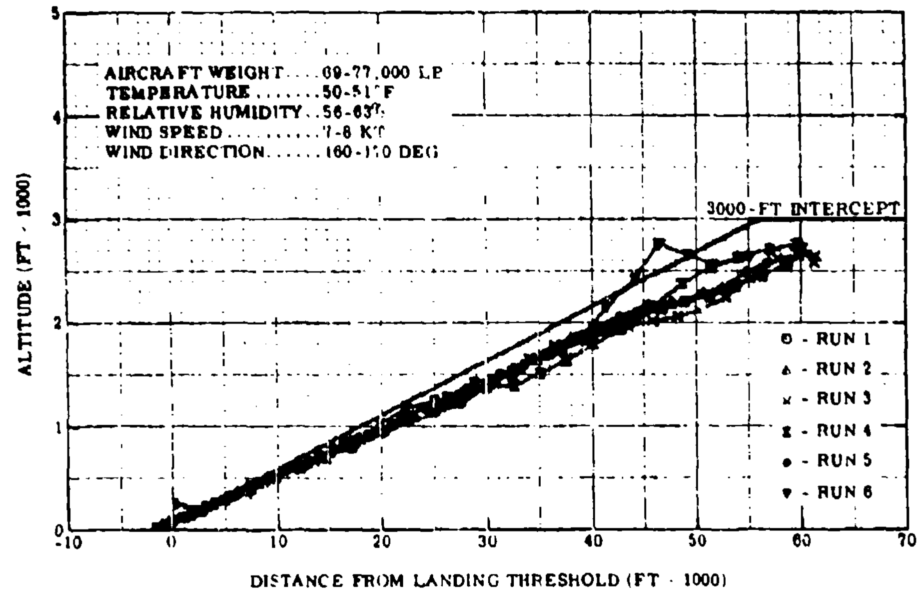

Figure D-39. Approach Profile A22, DC-9 Aircraft

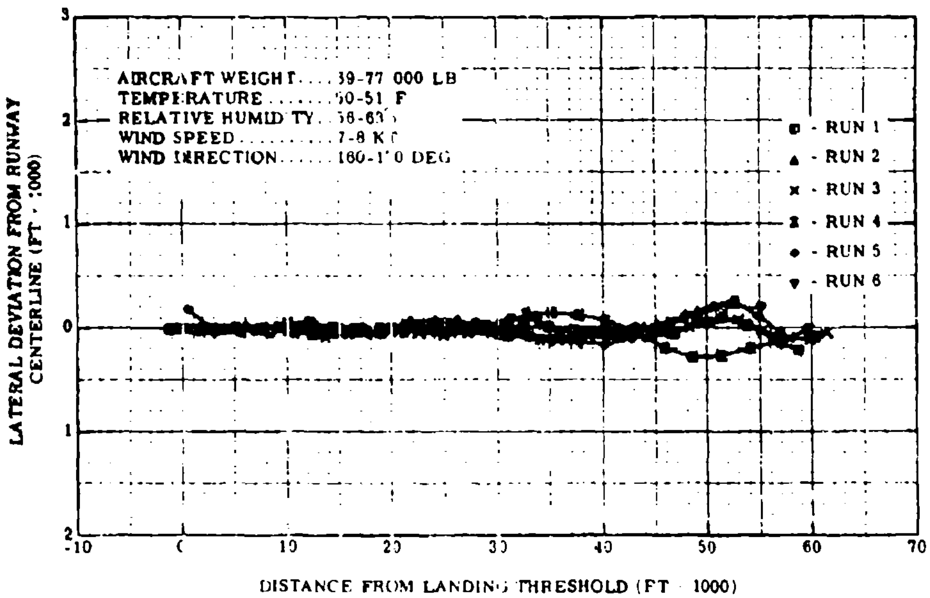

Figure D-40. Approach Lateral Deviation A22, DC-9 Aircraft

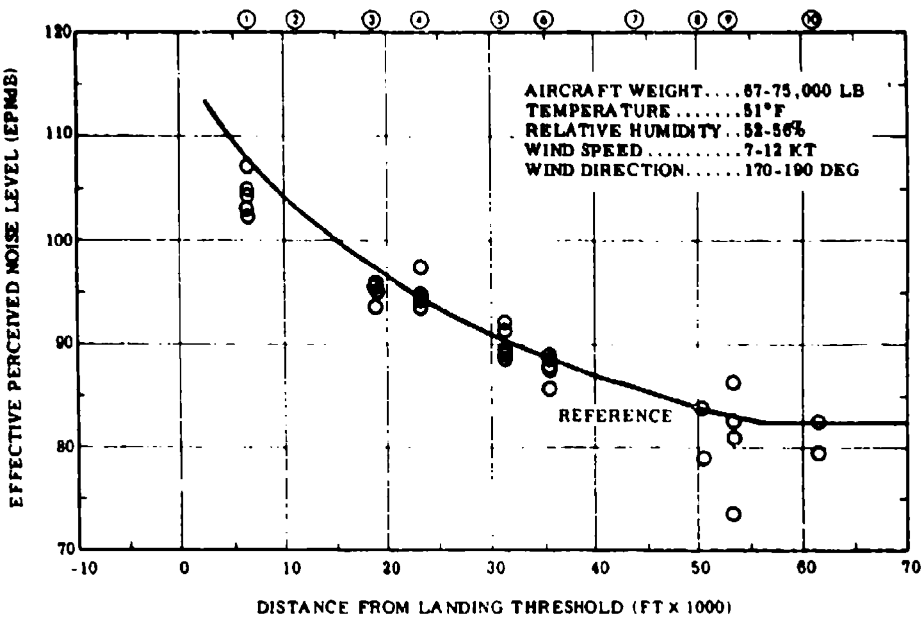

Figure D-41. Approach Noise Levels for Profile A23, DC-9 Aircraft

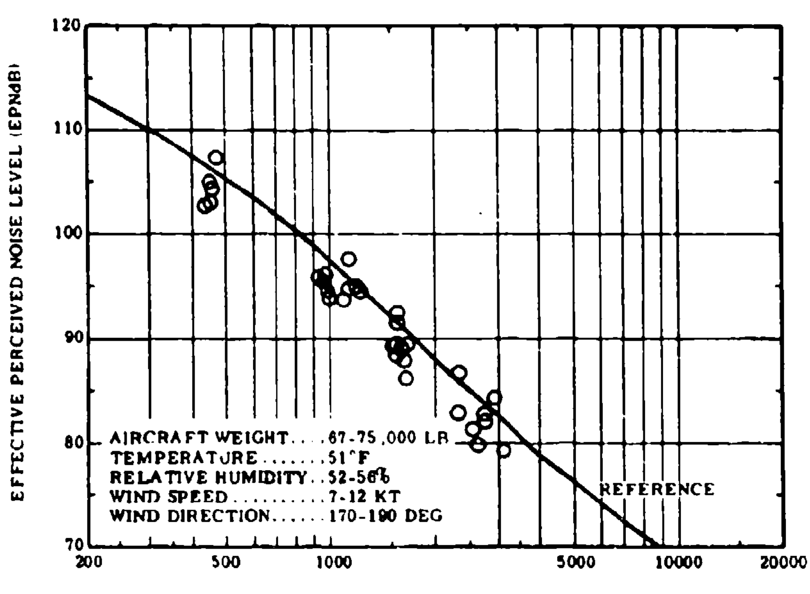

Figure D-42. Noise Levels as a Function of Slant Range for Profile A23, DC-9 Aircraft

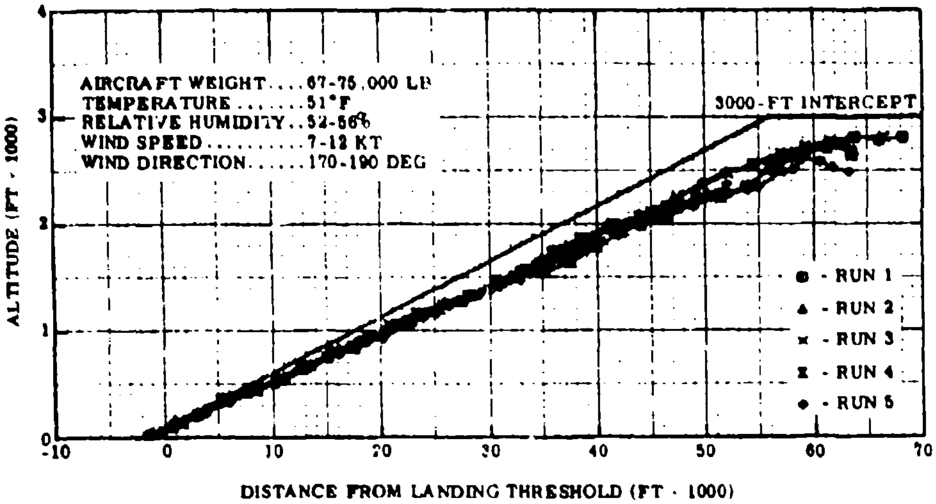

Figure D-43. Approach Profile A23, DC-9 Aircraft

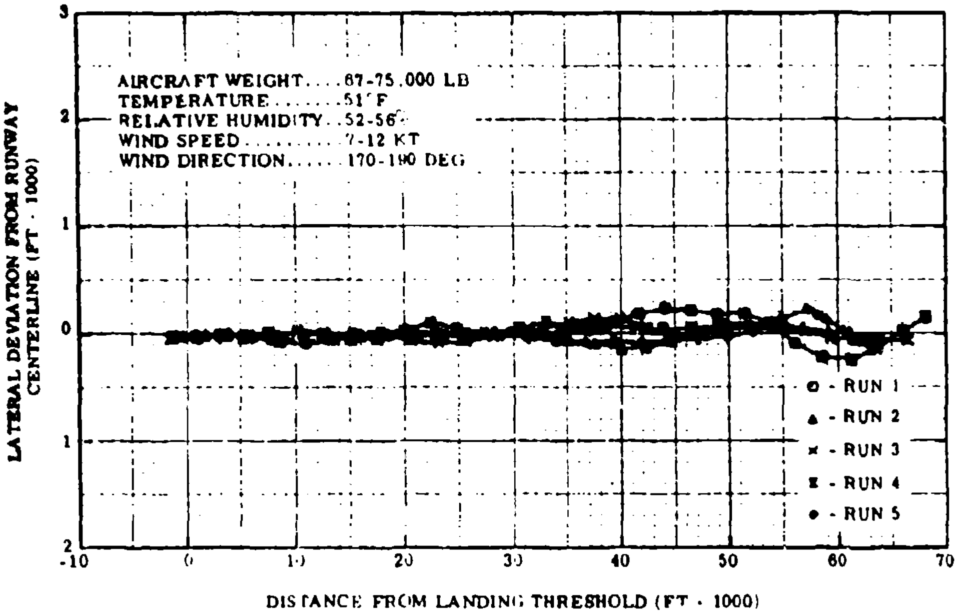

Figure D-44. Approach Lateral Deviation A23, DC-9 Aircraft

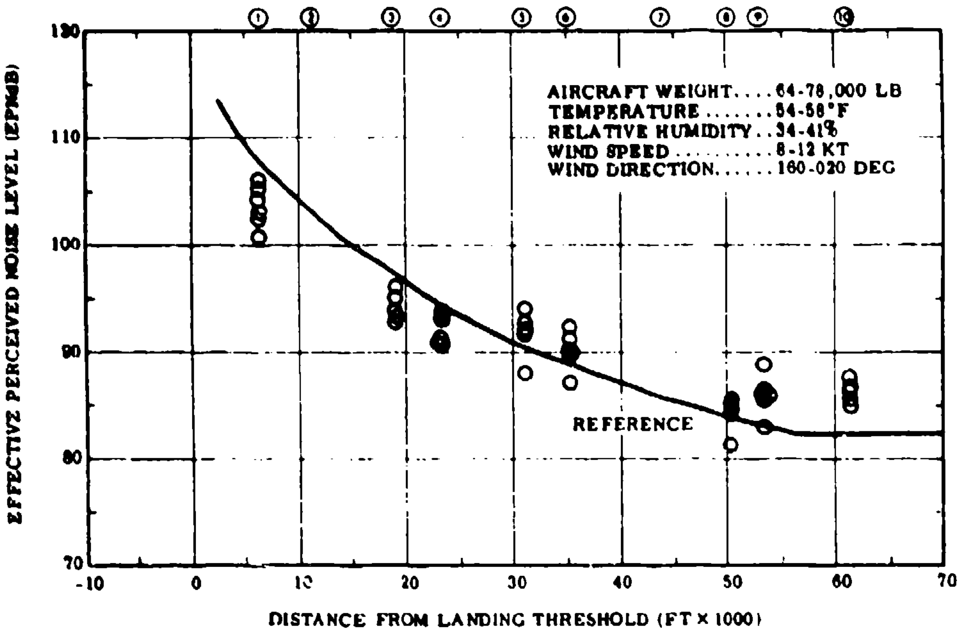

Figure D-45. Approach Noise Levels for Profile A31, DC-9 Aircraft

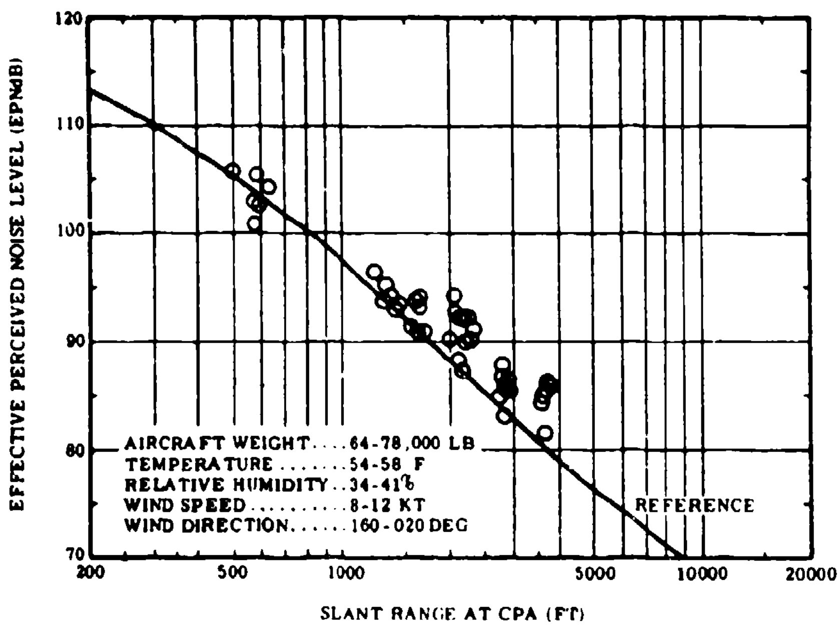

Figure D-46. Noise Levels as a Function of Slant Range for Profile A31, DC-9 Aircraft

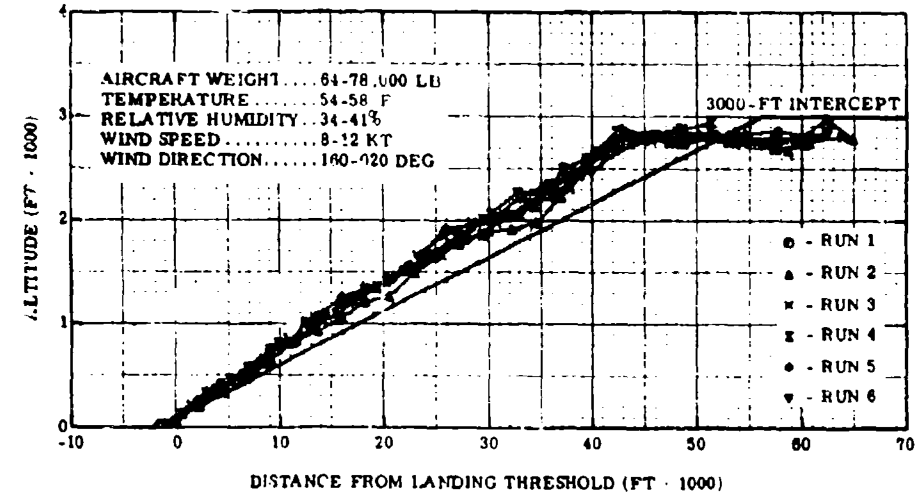

Figure D-47. Approach Profile A31, DC-9 Aircraft

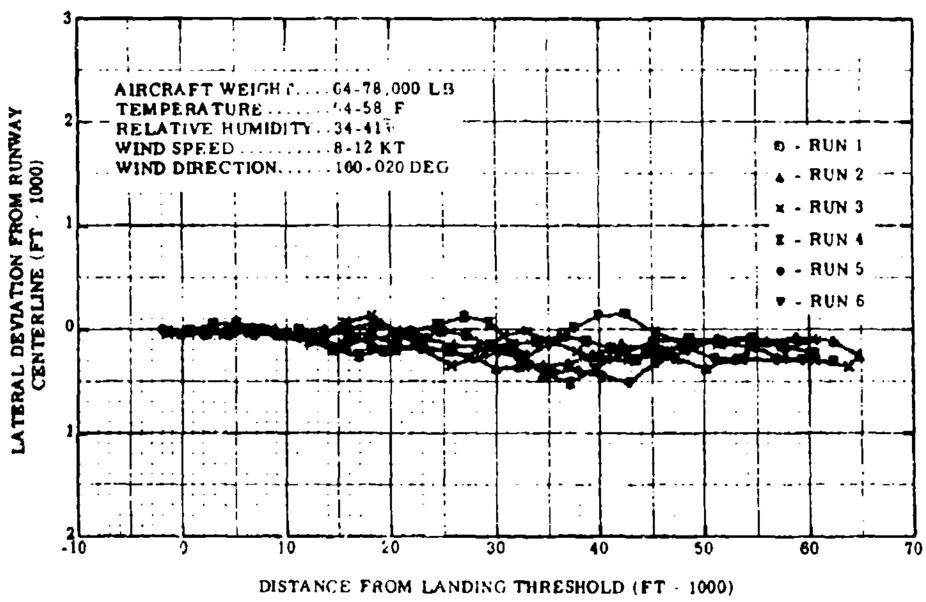

Figure D-48. Approach Lateral Deviation A31, DC-9 Aircraft

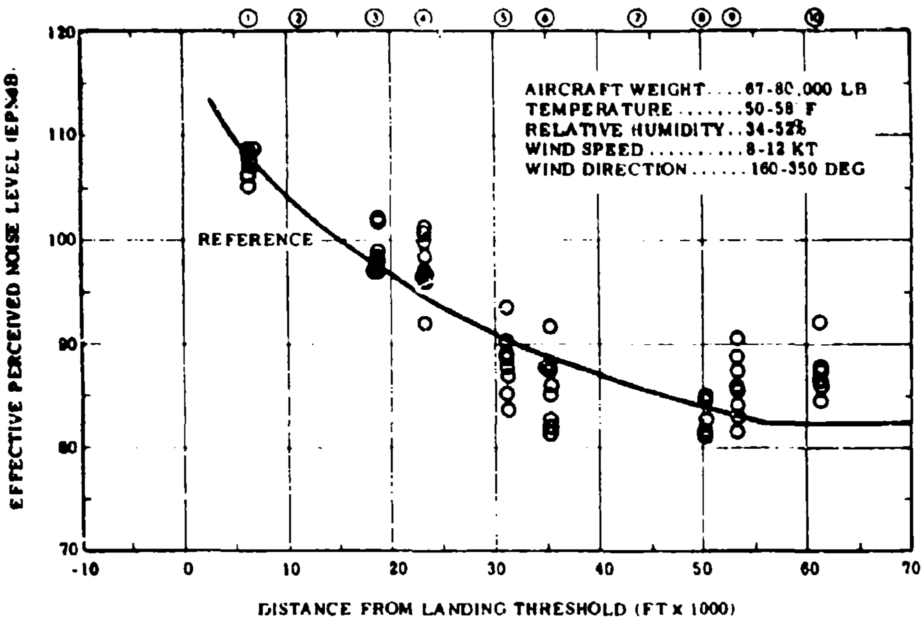

Figure D-49. Approach Noise Levels for Profile A41, DC-9 Aircraft

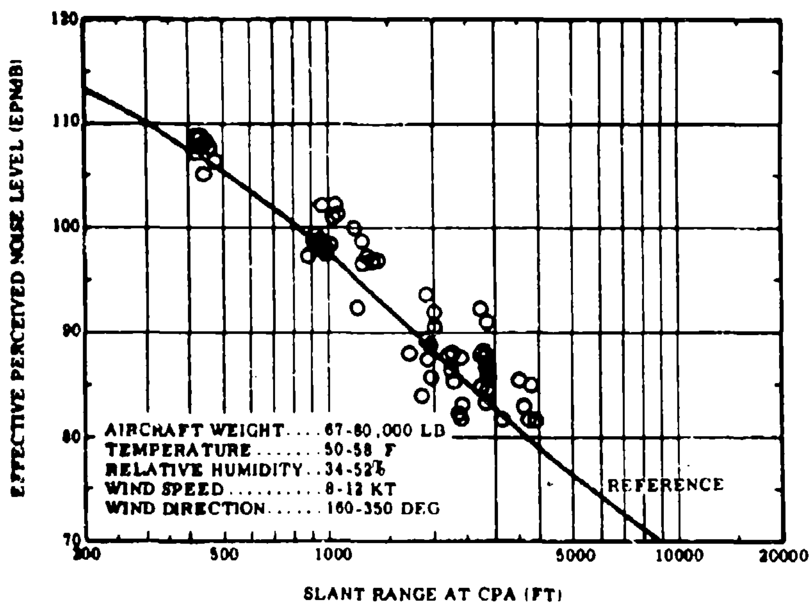

Figure D-50. Noise Levels as a Function of Slant Range for Profile A41, DC-9 Aircraft

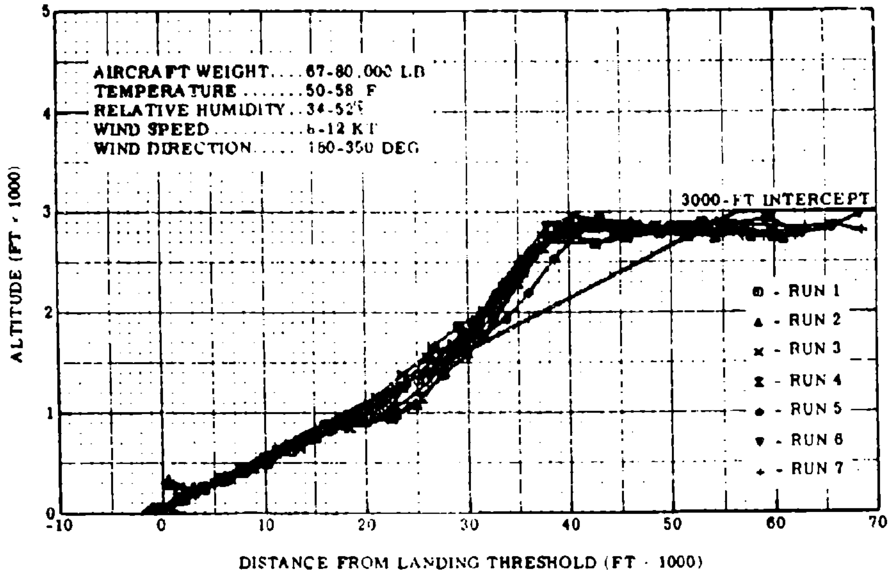

Figure D-51. Approach Profile A41, DC-9 Aircraft

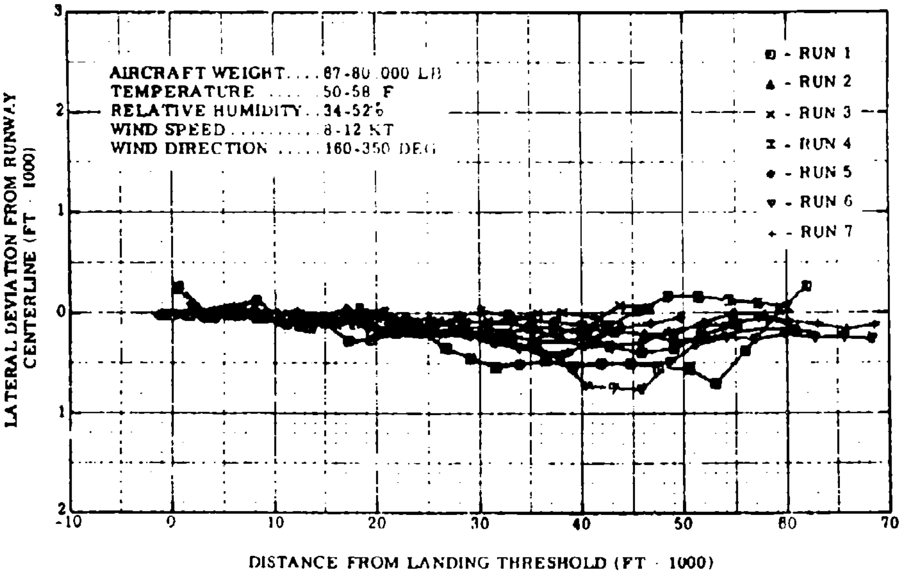

Figure D-52. Approach Lateral Deviation A41, DC-9 Aircraft

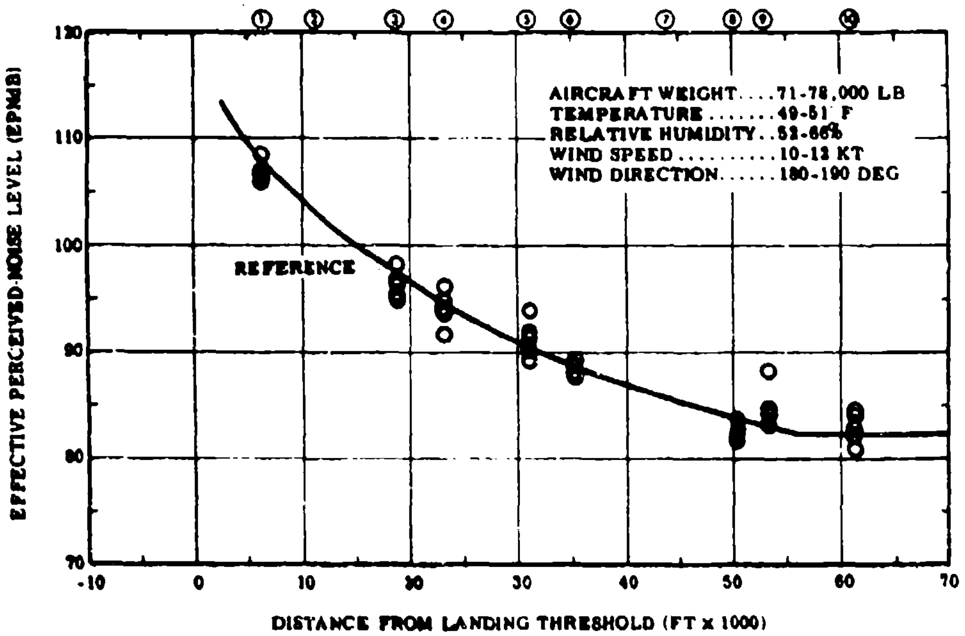

Figure D-53. Approach Noise Levels for Profile A51, DC-9 Aircraft

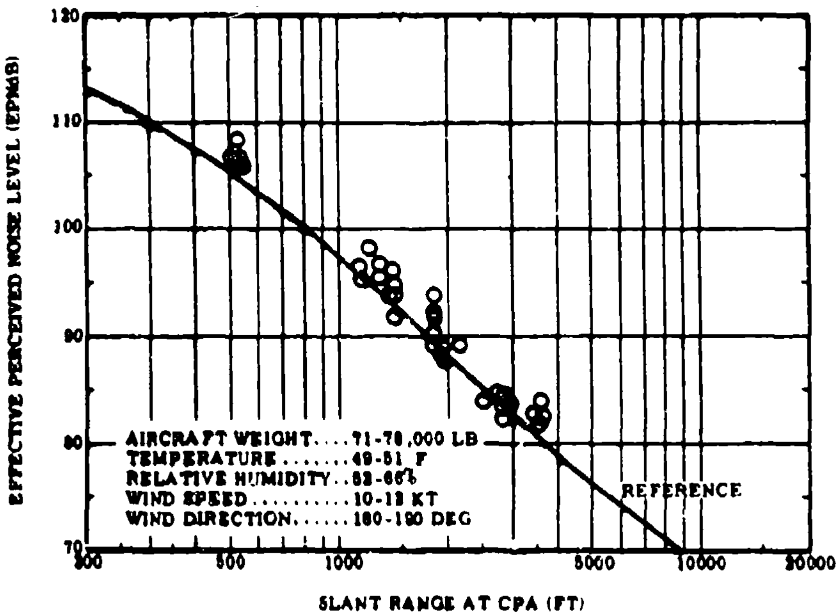

Figure D-54. Noise Levels as a Function of Slant Range for Profile A51, DC-9 Aircraft

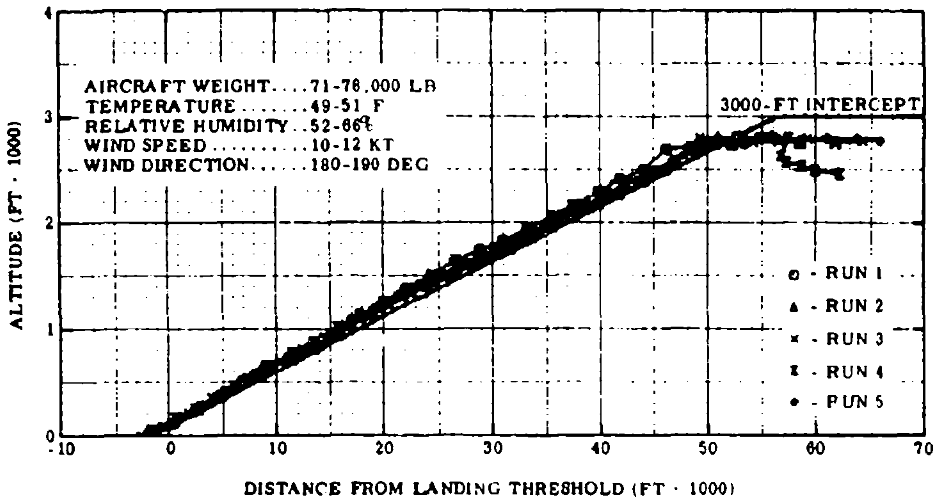

Figure D-55. Approach Profile A51, DC-9 Aircraft

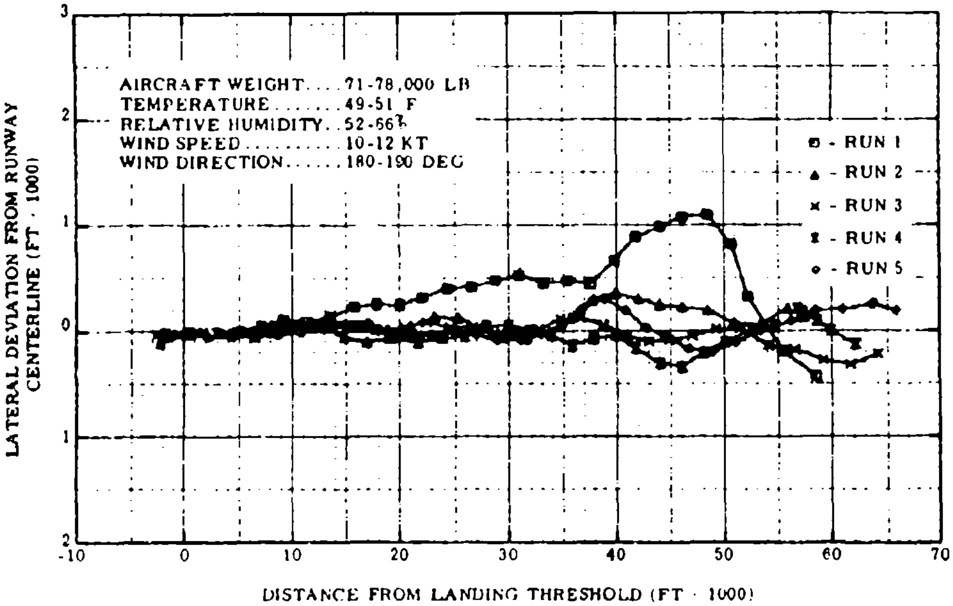

Figure D-56. Approach Lateral Deviation A51, DC-9 Aircraft